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ABSTRACT

This science curriculum guide for grades 7-9, developed by the Manitoba Department of Education, attempts to correlate information known about the intellectual and social development of young adolescents with the nature of science education. The curriculum provides opportunities for students to examine how humans grow and develop, how humans differ from and resemble each other, and how humans differ from and resemble other organisms. Another emphasis is placed upon environmental education, in which topics such as energy conversion, alternative energy sources, and the role of energy conservation are explored. Skills emphasized include the selection and ordering of data, the determination of the effect of variables, and how evidence is weighed. Core objectives are provided for each grade level, classified by subject area and identified as concept or process objectives or psychomotor skills. (Author/CS)

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This guide was prepared by the Department of Education to meet the needs of the students of Manitoba. The interim form of this guide has been in schools since November 1976 and has been revised on the basis of feedback from teachers during the period 1976-78. It has been designed to articulate with the new K-6 Science guide and to provide basic concepts and skills which will be useful to students continuing in the sciences.

This guide becomes effective generally in September 1979, with the implementation of the grade 8 program not later than September 1980, and the grade 9 program not later than September, 1981.

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1. Introduction

RATIONALE

During the 1960's, science and technology were generally perceived to hold the promise of a bright and expanding future for mankind. With the arrival of the 1970's, however, this view was modified: while advances in the technology of nuclear energy provided an additional source of energy, concerns were expressed about the disposal of wastes; and while the development of organic pesticides saved millions of lives, the balance within some ecological systems was seen to be adversely affected. The growth and application of scientific knowledge were increasingly viewed as having possibilities for both positive and negative impacts upon human progress.

The continuing debate about the advancement of scientific knowledge and about the role of science in the society of the future has been paralleled by a re-assessment of the role of science education within the school curriculum. During the 1960's, the function of science education was expressed in terms of helping students to develop concepts and processes. During the mid-seventies, a survey of Manitoba grades 7-9 teachers indicated a need to retain a general, integrated science orientation in order to retain a balance among the major ideas that would aid the student in understanding his/her environment; and to provide a flexibility within the design of the program and support materials. Consequently, the function of science education is being redefined in terms of the relationship between concepts, processes and values, and their potential contribution and relationship to the intellectual and psychological growth of the student.

Because grades 7-9 students are at various stages of physical and emotional development and are experiencing rapid physiological changes which lead them to redefine their relationships with others, the science curriculum should provide opportunities to examine how humans grow and develop, how humans differ from and resemble each other, and how humans differ from and resemble other organisms.

Students are presented with opportunities to examine ways in which man has extended his abilities to explore and utilize the environment, ways in which changes in the environment take place, and ways in which people have interfered with those changes; for example, the concepts of energy conversion developed within the program may be used by the student to examine future energy needs, alternative energy sources, and the role of energy conservation.

Students are bombarded with a rapidly increasing amount of information, much of it conflicting. Consequently, they need to develop skills which enable them to organize and determine the validity of available evidence in order to reach intelligent conclusions. The science curriculum provides opportunities to select and order data, to determine the effect of variables, and to weigh evidence. Inquiries into the factors affecting erosion of the soil by water, or the pulse rate of the heart, and inquiries into the effect of exercise upon the rate of circulation of the blood, are representative activities supporting this aim.

LEARNING THEORY AND THE DESIGN OF THE PROGRAM

The 7-9 science program attempts to correlate information known about the intellectual and social development of young adolescents with the nature of science education. Current research indicates that most middle years students are in transition from a concrete to a formal stage of intellectual development. In grade 7, the majority of students will utilize concrete thought whereas by grade 9, about 30% of the students will have begun to be formal thinkers.[1] Almost all children will demonstrate both stages of thinking on different occasions throughout this developmental period.[2]

Some characteristics of the concrete operational child are the following:

- Can solve problems involving concrete situations where actual objects can be observed and manipulated and can discover relationships but not conceive possibilities;
- Can isolate some of the variables present in a situation but has difficulty in separating relevant from irrelevant information. When attempting to find a solution, the child tends to consider one factor at a time and ignores all others;
- Does not understand the concept of density except that it is related to mass and size in some way;
- Can measure and understand time intervals up to a year but has an inadequate grasp of longer intervals;
- Can establish relationships between two series involving direct variation with two variables only and in concrete situations only.[3]

Some characteristics of the formal operational child are the following:

- Can solve theoretical or abstract problems by manipulating words and/or symbols;
- Can isolate and control variables and test a problem systematically;
- Can understand the concepts of density and displacement;
- Can establish relationships between variables.

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1. J.W. Renner et al, "Content and Conrete Thought", *Science Education*, April-June, 1978, p. 220.
2. J.D. Novak, "Epicycles and the Homocentric Earth: or What is Wrong with Stages of Cognitive Development?" *Science Education*, 61(3), 1977, p. 394.
3. Australian Science Education Project, *A Guide to ASEP*, State of Victoria, 1974.

Acceptance of the preceding concepts implies that the program design should provide for the following:

- Topics and activities which are oriented towards a concrete approach;
- A gradation in the sophistication of topics from grades 7-9;
- Flexibility of teaching approach;
- Flexibility within a specific topic using activities or extensions representing different levels of intellectual development;
- A time allotment which will enable teachers and students to explore core topics or additional topics according to the interests and needs of students.

IMPLICATIONS OF LEARNING THEORY FOR THE SCIENCE PROGRAM

The design of the 7-9 science program is related to learning theory in the following ways:

1. The more concrete oriented topics have generally been placed early within the program. For example, the chemistry program in grades 7 and 8 is oriented towards the observable and classifiable properties of matter and change. At the grade 9 level, however, some of the underlying and more abstract principles are introduced in order to relate or unify the concepts of physical and chemical change. For example, the generally abstract topic of genetics which is concerned with the passage of characteristics from generation to generation, is not introduced until grade 9 and suggestions, even at that time, are given to make the activities as concrete as possible, e.g., the examination and comparison of specific student characteristics within the classroom;

2. Young adolescents display a need to understand their relationship to their peers and to their society. They are thus constantly interacting with each other, testing assumptions, and developing conclusions about the ways in which the environment operates and changes. Through examining human growth and development, heredity and variation, the program provides background which the students will use in attempting to understand their world;

3. Variation among students is considered within the design of the program in two ways. Firstly, the program attempts to provide flexibility by means of suggesting and developing different approaches to program organization and by defining a core of objectives which will represent the minimum coverage for students by the end of grade 9. For example, the extensions within the grade 8 unit Human Organ Systems suggest the development of more difficult concepts or the relating of concepts developed within core to similar concepts within other areas of study. Secondly, time is available beyond the core requirements which will allow teachers to provide depth or variety of extensions according to the needs of their students;[4]

4. Support materials varying in reading level and dealing with a multiplicity of student activities have been suggested.

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4. W. Wollman, "Controlling Variables: Assessing Levels of Understanding", *Science Education*, 61(3), 1977. This research indicates that in order for students to develop the idea of controls, the following ideas should be considered: 1) without a wide variety of experiences, the general concept of a controlled experiment is not likely to develop and 2) different subject matter will do although science offers the simplest situations.

GOALS AND OBJECTIVES OF THE 7-9 SCIENCE PROGRAM

Goals

1. To encourage self-awareness in and to help the student understand the environment and the interrelationships that exist within it.

2. To help the student develop the skills and attitudes necessary to inquire systematically into questions concerning the natural world.

3. To help the student understand the impact of science and technology upon the human and natural environment.

4. To help the student develop positive attitudes towards science and its potential role in society.

Objectives

1. To enable the student, as a learner and investigator, to develop and use the skills of science. These skills should include :

   - science process skills;
   - interpretative and computational skills based on collected data;
   - communication skills related to the gathering and interpretation of information, the presentation of data, and the presentation of tentative conclusions;
   - those psychomotor skills which are required for first-hand investigations.

2. To increase the student's knowledge of basic concepts of life, earth, and physical sciences so that he/she is able to:

   - interpret and evaluate fundamental ideas;
   - relate scientific concepts to everyday life;
   - make informed choices in future studies or careers.

3. To help the student develop a critical awareness of the interaction between science, technology, and the individual or society. Interactions can be represented by such issues as the effect of scientific and technological discoveries upon consumer goods, rates of resources development, methods of communicating and changing attitudes, and problems in transportation.

4. To develop the student's interest in and appreciation of scientific values and problem-solving; to promote attitudes of curiosity and open-mindedness; to promote respect for accuracy, precision, and opinions based on adequate evidence; to promote belief in cause — effect relationships.

5. To train the student in safe laboratory practices entailing proper care of equipment, correct experimental procedures, and appropriate work habits.[5]

5. See *Safety in Science for Manitoba Science Teachers*, Manitoba Department of Education, 1973.

A GENERAL PROGRAM OVERVIEW

The middle years, beginning at eleven years of age and ending by fifteen or sixteen, is a distinctive period of human development: it is a period of transition from childhood to young adulthood. Behaviour in this period is not consistent, but ranges and vacillates from mature and responsible to thoughtless and irresponsible. The rate of physical, emotional, and social development varies widely in students of the same age.

During this period, physical development proceeds rapidly and, linked with the onset of puberty, gives rise to coordination problems, lethargy, and concern about relationships with peers. The science curriculum provides opportunities to understand behavioural and other changes by including topics on human body systems, genetics, and mammalian reproduction. The uncertainty which occurs in students because of the changes they are undergoing provides the school and parents with an excellent means of establishing relevant communication with these students. Listening to, questioning, providing supportive comments and some guidance are important means of maintaining meaningful communication.

This is the period in which students begin to think abstractly. They begin the period using concrete thought, i.e., putting problems in concrete terms where doing can support thinking. By the end of the period, they are drawing conclusions from previous learning and applying principles to new problems.

The Science 7-9 curriculum supports this development by emphasizing student examination of the behaviour of living and non-living objects. By observing and measuring the interaction between objects and then organizing the information which was gathered, students are given opportunities to draw conclusions and apply this knowledge to the behaviour of objects in their environment.

Parents can play a role in this process by discussing the advantages or disadvantages of alternative solutions to science related problems such as energy and consumer related issues.

This is a time of observing, measuring, questioning, classifying, and theorizing. Parents can support this development by encouraging students to develop skills and interests in hobbies such as gem polishing, rock collecting, wildlife photography, amateur radio, and science fair projects. This enables the student to work with others who have similar interests and build his/her confidence in a variety of areas.

1. Specific goals have been suggested for each grade. Every student will not be able to reach these goals at the same time; however, the goals provide learning directions.

2. The science program defines a core set of topics and objectives requiring about 60% — 70% of the time available for science. The definition of a core set of topics prevents repitition in cases where a student transfers from one school to another. In addition, the objectives support the development of both concepts and skills. The skills which include measuring, calculating and graphing are developed within a number of related subjects such as mathematics and are important if students wish to continue in the study of science.

3. The science program provides students with a general science background, i.e., at each grade level, topics are chosen from a number of areas of science. The core topics at the grade nine level present comparatively abstract ideas which are developed from the simpler concepts studied in earlier grades.

4. Flexibility within the program is provided by extension topics and objectives which vary in their intent and sophistication. For example, some topics are extended into the practical area of examining the quality of clothes from a scientific viewpoint. Other objectives will emphasize more abstract ideas. Different student needs may be considered by having students examine different topics or attempt different activities or projects.

5. The use of the local environment enables the student to examine ideas in a concrete manner. Parents may be asked to support this approach by assisting occasionally in supervision, sharing information or skills with the class.

N.B. Schools may find the General Program Overview particularly useful in describing the Science 7-9 program to parents.

2. SI: Effects on the Grades 7-9 Science Program

Although a version of the metric system has always been an integral part of the science program, Canada's conversion to the use of SI (Système Internationale) will affect some aspects of 7-9 science. Advantages of converting the science program to SI lie in the internal coherence of SI and in the ease of conversion of one unit of measurement into another. For example, the force unit (newton — N) is easily converted to the energy unit (joule — J or N•m) and the energy unit is related to power within the watt (W = J/s).

On the other hand, some units which have been in common use are no longer acceptable. Heat energy will be measured in joules rather than calories.[6] A number of basic changes which affect 7-9 science are outlined below; however, teachers should refer to the *Metric Style Guide* for detailed information.[7] Additional aid is available from *Science Teacher's Guide to Metrication*.[8]

SOME IMPORTANT CHANGES IN THE METRIC SYSTEM

- Degrees centigrade becomes degrees Celsius. °C
- Cycles per second become hertz. 1 Hz = $1s^{-1}$
- Forces are expressed in newtons. $N = kg \cdot m/s^2$
- The unit of energy is the joule (J). The calorie is replaced by the joule. J = N•m
- The symbol cc is written as cm^3.
- The term "weight" is better expressed as mass or related to the force of gravity.
- Pressure will be expressed in pascals (Pa). Atmospheric pressure is about 100 kilopascals. $Pa = N/M^2$ k Pa

SOME GENERAL PEDAGOGICAL CONSIDERATIONS

1. Determine students' previous experiences in elementary school. New programs in mathematics and science should aid students in developing measurement skills in length, area, volume, temperature, and mass. Students should be familiar with the base units and prefixes such as centi, deci and kilo.
2. SI should be implemented throughout the science program and other subject areas on a coordinated basis.
3. As new units of measurement become required within the topics studied, concrete examples of them should be demonstrated; for example, the newton of force may be initially developed by lifting or holding different masses, by measuring different masses with a spring scale graduated in newtons, and by determining the force of friction for objects sliding over a surface.
4. Relationships among units can be introduced when a new unit is presented; however, numerical conversions should be developed as the need arises.
5. Relate conversion to SI to changes in the world outside school.

6. 4.18 joules (approx.) = 1 calorie.
7. Council of Ministers of Education, *Metric Style Guide*, Toronto, 1975. This document was distributed to Manitoba teachers in the fall of 1975.
8. The document *Science Teachers' Guide to Metrication* (Department of Education, Manitoba) was sent to Manitoba schools in the spring of 1979.

SI Units Introduced in Grades 7-9 Science

1. Maintain and use the following measurements developed in elementary school:

   length — cm, dm, m, km
   area — cm^2, m^2, km^2
   volume — cm^3, dm^3, m^3, L, mL
   mass — g, kg
   temperature — °C
   correct use of symbols

2. Introduce and use the following:

   force — N
   cycles — Hz
   energy — J
   pressure (weather) — Pa
   relationships and conversions as needed, e.g., cm to m, g to kg

SI AND MATERIALS

Whenever possible, published materials which use SI have been recommended. Most equipment which is used in laboratories is unaffected by conversion to SI. Some measuring instruments which may be affected are meters which provide direct readings in units of force and pressure. These instruments may be adjusted temporarily by replacing the scale with an overlay expressed in newtons or pascals.[9]

9. Refer to *Science Teachers' Guide to Metrication* for additional ideas.

3. Science 7-9 and the Special Student

IDENTIFICATION OF EDUCATIONALLY DISADVANTAGED STUDENTS

Educationally disadvantaged students may show one or more of the following characteristics:

- Have repeated one or more grades;
- Read below their grade level;
- Have difficulty with basic mathematical processes;
- Have required a number of resource supports during the elementary grades;
- Are having personal problems;
- Because of early cultural background and inadequate educational opportunities, are in need of time and support to gain confidence to work successfully in a regular program;
- Generally have difficulty functioning in the regular class environment.

GUIDELINES IN THE CHOICE OF TEACHING TECHNIQUES AND METHODS

1. Learn as much as you can about students in terms of:
   - reading level,
   - standardized test scores,
   - medical background,
   - attitude and behaviour as revealed by reports from all support services including parents.

2. Be aware that students are at a concrete stage of development.

3. Be aware that students are concerned with the immediate and practical effects of science.

4. Provide an improved articulation of science core units vertically and horizontally. Students comprehend more in terms of related facts.

5. Select appropriate science materials (low reading level — high interest).

6. Plan activities and assignments of reasonable length.

7. Develop science vocabulary gradually.

8. Structure lab activities with consideration for the organizational and language problems of the students.

9. Consider the following techniques:
   - multi-sensory approach;
   - project approach — hobby, crafts, etc. (Can also be integrated with Industrial Arts, Home Economics, and other subjects);
   - utilize students' personal experiences.

10. Evaluation of the students' work must be prompt, although it can be informal.

SUGGESTED WAYS OF TEACHING EDUCATIONALLY DISADVANTAGED STUDENTS

1. Remedial classes can be set up. In this arrangement, students are selected from feeder schools through cooperative efforts of the teachers of grade six classes, resource teachers, and guidance personnel. Beginning in early March, tests are given in reading and mathematics by the elementary school and the resource person; subsequently, conferences are held to discuss the results and a confidential written report is prepared by the homeroom teacher and the principal. In addition, visits to the feeder school are made by the receiving teachers and/or the 7-9 school-guidance counsellor. Movement among the classes is encouraged during the year. Students can be moved into the basic and regular programs within the same level. This, so far, is one of the best arrangements in dealing with slow learners in school.

2. Students in a science class usually work in groups: to be included in a group of brighter students would be most beneficial for the slow learner.

3. The help of some senior high students (grades 11 and 12) can be utilized in a class with slow learners.

4. Set up individualized instruction in small classes.

IDENTIFICATION OF GIFTED STUDENTS

Gifted students may show one or more of the following characteristics:

- Perform outstandingly in all academic subjects;
- Show superior achievement and intelligence as measured by standardized tests;
- Are in excellent physical health and have a good attendance record;
- Have an unusually advanced vocabulary for their age and grade level;
- Read a great deal, preferring adult level books;
- Prefer to work independently and require little direction from teacher;

- Are often self-assertive;
- Display a great deal of curiosity about many things;
- Are usually uninhibited in expressions of opinion;
- Assume responsibility well and are cooperative.

GUIDELINES IN THE CHOICE OF TEACHING TECHNIQUES AND METHODS

1. Provide a wide variety of materials and resources.

2. Enrich the program rather than accelerate students.

3. Place emphasis on reading.

4. Encourage students to pursue problems of special interest to them.

5. Provide the students with more independent activities. Science activities can give opportunities for the development of the qualities of leadership.

6. Use science clubs and other extra curricular activities to maximum advantage.

7. Develop students' manipulative and intellectual skills. The manipulative skills include abilities to perform standard lab operations, to use measuring devices, and to make careful records. Intellectual skills include abilities to observe carefully, to draw conclusions from observations, to apply these conclusions to generalizations, and to apply previously learned knowledge in new situations.

8. Organize seminars and tutorials. Students could present their papers to the class and comment on the work of other students. Papers may also be prepared for publication in these classes.

9. Enrich the program by making use of community resources, facilities, and people.

The revised science curriculum for grades 7-9 provides materials for both the educationally disadvantaged and the gifted student. The extensions for each core topic will help enrich the science program for the gifted student.

4. Design of the Program

In designing this program, the committee adhered to seven basic premises:

1. A general science structure, a positive feature of past Manitoba junior high science curricula, was not only maintained but was strengthened by specifying that topics from each of the six areas of science would be studied each year. These six areas are environment, life, earth, space, physics, and chemistry;

2. The science curriculum for grades 7, 8 and 9 is fully described in this guide. In other words, the guide IS the curriculum;

3. In order to encourage the teaching of fundamental science principles, the guide specifies core objectives. It is assumed that the core topics require about sixty percent of the time available for science. Teachers are expected to pursue some topics beyond core. They may select additional activities from the "Extension" objectives listed in the guide or may develop alternative extensions according to their own or their students' interests;

4. In addition to science content, the processes of science are stressed throughout the curriculum. To encourage the student to become an increasingly active investigator of science is an important objective of science instruction. This objective will be satisfied through a conscious, systematic development of the processed of science. Through process development, the student will become better equipped for more complex learning in science as well as in other areas of investigation.

   Instruction in the following processes begins in the elementary grades and continues through grades 7, 8, and 9. Skill in these processes is considered to be essential to the student's science education: observing, classifying, communicating, measuring, hypothesizing, defining operationally, controlling variables, collecting and interpreting data, inferring, modelling, theorizing.[10]

   The core objectives of this program are structured in order to draw attention to the processes of science. Numerous process objectives are specified and many of the content objectives encourage the use of science processes while achieving the content.

   Science processes can be practised in every science class. Since they are intellectual rather than manipulative skills, they do not demand an entirely activity oriented program, but can be developed in lectures, demonstrations, and discussions;

5. Materials which vary in their emphases on content or laboratory activities have been recommended in order to provide schools with a number of alternative organizational patterns; modular materials present one section or unit at a time and can readily be used by a number of classes during the school year; textbooks tend to be designed for specific grade levels such as grade 7 life science, grade 8 earth science, and grade 9 physical science. Although textbooks can be used with different groups of students, schools must consider that the conceptual level of some texts may be too difficult;

6. Many of the materials recommended for use by the students are published in SI editions. When materials are not totally SI, teachers should use proper SI terminology in all activities. Additional guidance in the correct use of SI units is available in *Science Teachers' Guide to Metrication* distributed by the Manitoba Department of Education in 1979;

7. While a core curriculum has been identified, a large measure of flexibility is built into the program. Flexibility is achieved through the use of different recommended materials, selection of various extensions to accompany core, and the use of different teaching approaches and classroom organizations. Feedback from pilot schools indicates that the amount of time required to develop the science course is approximately twelve percent of the total time available.

APPROACHES TO TEACHING 7-9 SCIENCE

The degree of success of any 7-9 science program rests not so much upon the content of a particular book as it does upon the ability of a teacher to assist students to meet certain core objectives in a number of science areas.

With this in mind, the committee has sought to define and enunciate a number of teaching approaches which may be used by teachers both to meet the objectives of the program and to relate their teaching style to the new program of studies. Alternatives are provided for those who would like to experiment with new organizational models.

The following approaches are discussed in this guide:

A. Unit approach;
B. Process approach;
C. Thematic approach
   1) Interdisciplinary focus

10. These processes are further defined in the section entitled "The Process Approach", page 11.

2) Cross-disciplinary focus
3) Societal focus
   a) Scientific-technological model
   b) Issues model.

The core objectives and the variety of modular material which is available, when combined with one or more of these teaching approaches, will equip science teachers with the flexibility necessary to develop a science program to meet the needs of students in a highly scientific, technical, and environmentally conscious society.

A. Unit Approach

The unit approach to the revised program is analogous to the chapter approach utilized in the former science program. The course in a given year consists of six units, one selected from each of the component areas — environmental, life, earth, space, physics, and chemistry. Each unit is studied individually, rather than in relation to the other scientific disciplines; e.g., the study of light (grade 7) is made primarily from the viewpoint of physical science.

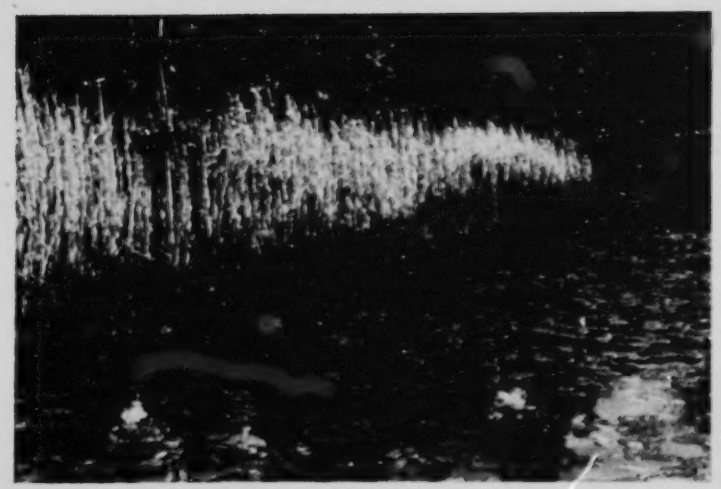
Each unit stands largely independent from the others. The entire course, however, is still unified and coordinated in both a horizontal (within grade) and a vertical (between grade) direction. Within each grade there is a common unifying theme which runs through each of the units. The concepts and processes stressed in a particular year provide a developmental and sequential treatment of the subject area studied.

Six weeks can be allocated to each of the six units comprising the course of study in a particular grade. The core objectives for each unit have been designed so that their associated concepts and activities can be covered in approximately four weeks. This allows for the development of topics to a degree in accordance with the interests and motivation of both teacher and students. Thus some units may be treated more intensively than others.

Developing a Model

Units may be studied in any sequence or in a sequence related to seasonal conditions. As an example, a possible arrangement based primarily upon seasonal considerations could be the following:

- September 3 — October 20, Environmental Science;
- October 20 — December 3, Earth Science;
- December 3 — January 28, Physics;



- January 28 — March 15, Chemistry;
- March 15 — May 3, Space Science;
- May 3 — June 21, Life Science.

Advantages

- This approach is familiar to many teachers and requires little extra preparation. Course work tends to be geared to one or two modules rather than to a variety of modules as may be the case in the thematic approaches.
- The independent nature of the units allows for flexible scheduling of them in accordance with personal preference, seasonal considerations, or the need to share materials among classes.
- The time schedule of six weeks per unit ensures that all units will be covered in a particular year.

Disadvantages

- There may be unnecessary duplication of skills and concepts that arise in different science areas.
- The lack of emphasized relationships between the science areas may present a fragmented view of science to the young student.

B. Process Approach

This approach focuses on the processes rather than on the content of science. We may formally define the processes of science as those skills, techniques, and habits used by scientists and students as they study and research science. The processes to be emphasized in grades 7 to 9 are the following: observing, classifying, communicating, measuring, hypothesizing, defining operationally, controlling variables, collecting and interpreting data, inferring, modelling and theorizing. Each of these processes is defined at the end of this section.

Methods

A teacher who utilizes the process approach will realize that development of process skills take precedence over covering content and memorizing facts. Students will need to practice the process in a variety of situations with varied content. The degree of emphasis to be placed upon the processes may be determined by the following three procedures:

1. This method may be utilized while following the unit approach, alloting six weeks per unit but practicing the processes whenever the opportunity arises. Measurement will be emphasized throughout. Students will be expected to hypothesize about demonstrations or experiments. They will be encouraged to collect and interpret their own data whenever possible. Models will be used when applicable;

2. This procedure stresses particularly the topics which lend themselves to practicing the processes. Other topics are considered only with respect to the basic core. In grade 7 chemistry, for example, emphasis could be placed on classifying materials in terms of states of matter, and less time devoted to diagramming the water cycle where there is little process learning. In this procedure, extension activities would be selected to reinforce the processes to be emphasized. In grade 7 space science, for example, observing and describing sun spots could be chosen extensions;

3. This is the most process-oriented procedure. Here content may be drawn from several areas simultaneously as one or more processes are being taught. The student may be classifying rocks from earth science, bacteria from environmental science and matter from chemistry. Hypothesizing, defining operationally, collecting and interpreting data may be practiced through experiments with light and food production in plants, experiments with reflection and refraction, and experiments with solubility.

Advantages

- Process knowledge is retained longer than content knowledge. That is, students will remember how to classify after the kinds of rocks are forgotten.
- The process approach is able to provide increased interest in and a fresh view of familiar material.
- The process approach could represent a unifying theme that would be consistent from school to school.
- The process approach allows for a greater selection of contents and activities. When studying the process of classification, for example, students could classify cars in a parking lot as well as bacteria or rocks.
- Almost all teaching styles can effectively incorporate a process approach. Since most of the processes are intellectual, they may be practiced through teaching styles which include question and answer, lecture, discussion and demonstration, individual student activity.

Disadvantages

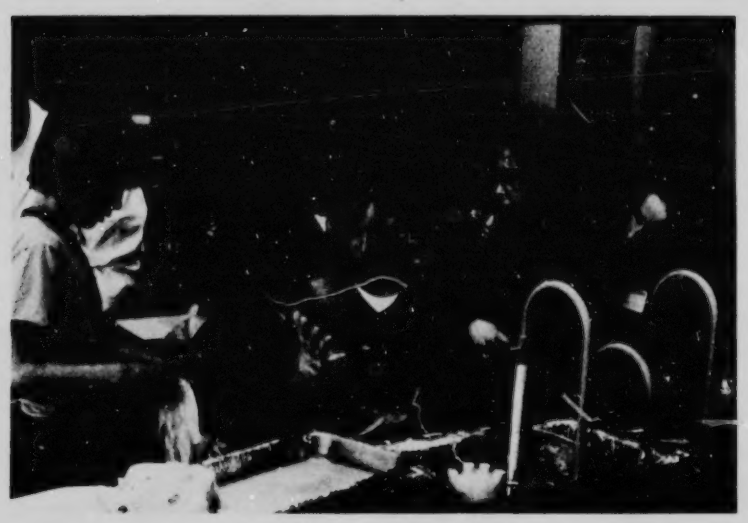
- Since the process approach does not stress concept development, the average student will probably learn less science content than through other approaches.
- Evaluation of process learning can be a problem as it is easier to test for the acquisition of facts than for the acquisition of processes.

Definitions of Processes

Observing: The use of all the senses, directly and with the aid of equipment, in order to take note of the properties and interactions of objects. It is the most basic of all processes. Observing would be the process stressed in mineral tests and microscopy.

Classifying: The ordering of objects according to their similarities and differences. Classifications are arbitrary but must be functional. Classification of rocks and of matter are only two examples of the many ways in which to practice this process. Two and three stage classifications will be attempted by grade 9.

Communicating: The reporting of data in any useful form. Data tables, graphs, models, and maps are used in addition to oral and written description. This skill is inherent in almost all activities in the science classroom.



Measuring: The act of quantifying observations, using both "home made" and SI units. It is a skill which involves appropriate instruments and units used with a considerable degree of accuracy. Measurement is studied in grade 7 physics but is involved in most science areas.

Hypothesizing: Making a statement about the expected relationship among the variables in an experiment. Students should make hypotheses such as: if the angle of the inclined plane is increased, the force required to pull the object up the plane will increase; if a plant does not receive sunlight, it will not produce food.

Defining operationally: Stating a definition in a manner in which the phenomenon can be observed. In grade 8 chemistry, "acid" may be defined as any material that causes litmus to turn red.

Controlling variables: The identification of important variables in an investigation and the recognition of those variables which should not be changed. In culturing bacteria in grade 8 environmental science, temperature is a variable that must be controlled.

Collecting and interpreting data: The use of information which has been gathered and compiled according to some purpose and in an organized manner. These data are used to determine relationships, draw inferences, or propose theories.

Inferring: The suggesting of other properties or behaviours beyond those revealed by observable data. Inferences concerning the nature of the molecular theory are made in the chemistry units.

Modelling: The use of a simplified, concrete representation of a more complex, abstract reality. Models are used in science to represent atoms, molecules, and cells.

Theorizing: Suggesting a generalized explanation which is believed to be true because it is supported by experimental evidence but which has not been proven. Theories are constantly produced, tested, and refined. Theories are used particularly in earth and space science and in discussion of molecules.

C. Thematic Approach

A thematic approach involves the use of concepts and skills as component parts leading to the development of a broad theme. Among themes which might be considered suitable are changes, cycles, energy, environment, society, and communication. Topics such as water or measurement could also be treated as themes. For the purposes of this program, the thematic approach is described from three different perspectives: a cross-disciplinary focus, an interdisciplinary focus, and a societal focus.

Limitations

There are several factors that limit the application of the thematic approach:

- Extra planning time is needed;
- No "step-by-step" manuals are available. The inventiveness and imagination of the teacher are controlling factors;
- The interests of the student determine in large measure which themes can be pursued;
- The nature of the class and school organization;
- The degree of acceptance and encouragement by the school administration exerts an influence on the teaching styles which may be used in this approach.

1. The Interdisciplinary Focus

Using an interdisciplinary focus suggests that the concepts and skills of two or more of the science disciplines are integrated. For example,

development of the theme of change could draw upon the concepts and skills of each of the six science disciplines (environmental, life, earth, space, physics, chemistry).

Teachers who are thinking of adopting an interdisciplinary focus for their teaching should be aware of the wide range of possible alternatives ranging from relating the concepts of biology of man, continuity of life, harnessing energy, and the use of materials, to relating the concepts of patterns (units) of organization and interaction. This range of alternatives could be developed in one grade or continued in two or three grades.

Advantages

- Assists the teacher in avoiding unnecessary duplication of concept and skill development.
- Permits considerable flexibility in program development.
- Suggests some of the interrelationships of the various science disciplines.
- Enables the teacher to pursue themes of interest to the student.
- Enables the school to capitalize on some specific expertise of the teacher.

Disadvantages

- Could promote unequal coverage and development of the core objectives.
- Could lead to unbalanced scheduling of time in the six science disciplines.
- Could lead to artificially relating objectives or artificially fitting objectives to a theme.

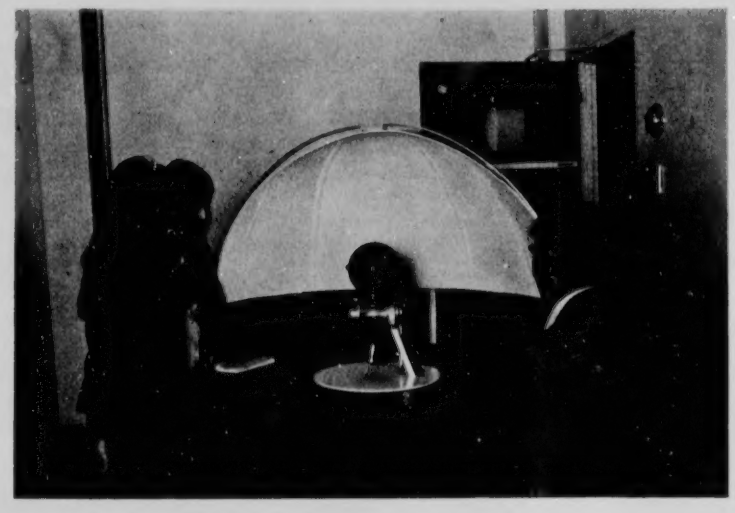
Developing a Model

Teachers are encouraged to experiment to determine those themes which are suitable to their classes. The following general principles should, however, be observed:

1. A theme should be chosen which is applicable to the grade level. Such themes as change, cycles, energy, measurement, and interaction within the environment are possibilities;
2. The degree to which the core in a specific grade contributes to the development of that theme should be determined;
3. A teaching strategy should be developed based on such considerations as the allotment of time for each topic, topics to be covered, sequencing of topics, skills to be developed, and activities which might extend the core;
4. The appropriate support materials should be obtained.

Suggestions

- *Measurement* should *not* be a topic in grade 7 physics only. Rather, it could be developed within the context of grade 7 earth science, grade 7 chemistry, grade 8 space science, and grade 9 physics.
- The theme of models might be used to develop some of the grade 9 program. Specifically, the atomic model in chemistry, a moon and sun model in space science, and a genetic model in life science might all be developed.
- The theme of change could be used to develop most of the grade 9 science program. The objectives in space science, earth science, physics, and chemistry can all be developed using the theme of change.



2. *Cross-disciplinary Focus*

The term cross-disciplinary is used to mean an integration of the subjects taught in grades 7-9. Thus, cross-disciplinary teaching involves teachers from different subject areas working together to develop a program for a group of students.

The number of teachers involved, the size of the group, the disciplines involved, and the degree to which the teachers relate the material, may vary considerably. However, in each case, the teachers working as a team would develop themes involving all of their subject areas. Within the team framework, teachers would have specific responsibility for their own areas of specialization but, at the same time, would be expected to contribute ideas to other areas. In an ideal situation, each team member would be involved in teaching all aspects of the program. Thus, each theme should represent a broad picture of a particular topic rather than the often narrow view of one discipline. Teaching techniques might vary from one in which each teacher teaches his own subject to class groups to a contract approach utilizing different sized groups on multi-level contracts.

Advantages

- Encourages professional exchanges between teachers of different subject disciplines.
- Promotes learning in the context of other disciplines.
- Enables teachers to avoid unnecessary duplication of concept and skill development.
- Enables teachers to organize within long time blocks, permitting considerable program flexibility.
- Enables teachers to accomodate difficult group sizes.
- Reduces instances of homogeneous grouping.
- Encourages consistency of concept and skill development.
- Enables teachers to gain a greater understanding of student needs by having the opportunity to spend increased time with their students and by sharing the resulting knowledge.
- Allows students to meet a wider range of people than in the normal school environment.

Disadvantages

- The success of this method depends to a large extent on maintaining a good working relationship among teachers.
- Scheduling large blocks of student time often leads to considerable problems in timetables.
- The heterogeneity of the student groups could lead to too many groups for the team to handle.
- Adequate time blocks need to be scheduled to accomodate team planning.
- There might be a tendency to relate the objectives to a theme artificially.

Developing a Model

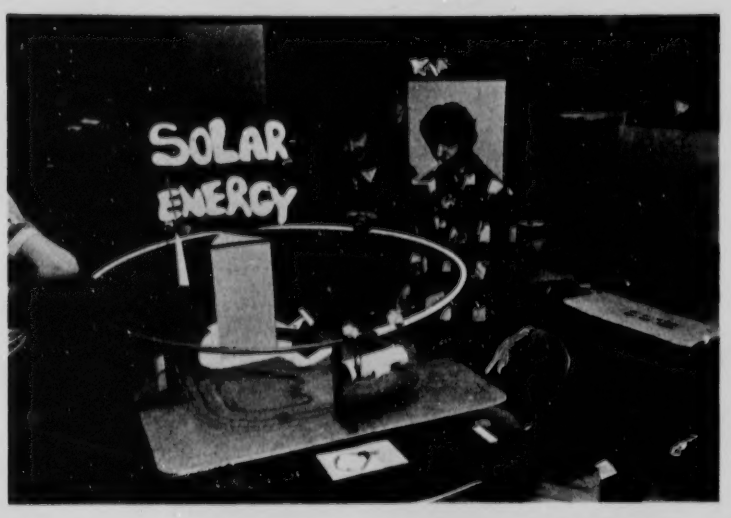
A cross-disciplinary model that has been used quite successfully is one in which a team of four teachers (one each from mathematics, science, social studies, and language arts) is responsible for the major portion of time (60%) of a students' education. Student options (second languages, art) might involve other teachers directly or could be treated as separate programs.

Steps in the Theme Development

1. Selection of theme.
2. Conferring with all team members.
3. Amplification of topic from conference results.
4. Development of approaches, either by individual member or members working in pairs.
5. Research of available materials and resources.
6. Development of final theme outline with the entire team.
7. Development of contracts for each reading level (single and group efforts).
8. Assignment of groups to teachers.
9. Collection of special materials.
10. Introduction (possibly by large group presentation).
11. Placing students into groups; informing students of any timetable changes.
12. Assigning contracts.

Possible Themes

- The City
- Origin of Man
- Communications
- Exploration
- Population
- Transportation
- Rural Study
- Man and his Environment
- History of Science
- Energy Crisis
- Pollution

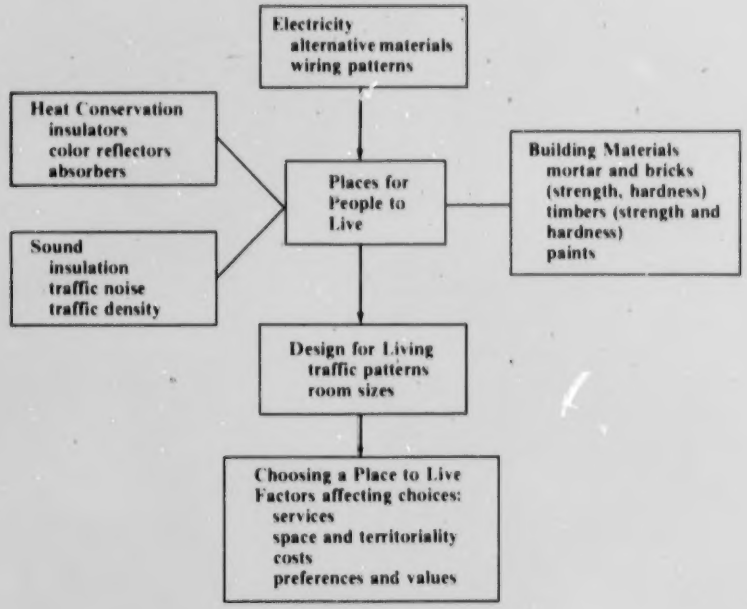


3. *The Societal Focus*

"Technological development has not only provided man with the means of adaptation, it has presented him with the problems of adaptation".[11] This statement suggests a need to help students consider ways in which science and technology affect man. The use of a variety of models are possible when examining the effects of science and technology upon man; however, only two models labelled the "scientific-technological" and the "issues" model are described in this guide. The concepts developed within the scientific-technological approach are applied within practical areas which may be of concern to students. An example of a theme which uses this model is represented by the following flow chart, entitled "Houses and Territory". This theme could be developed through experimentation, library research, surveys, and a variety of other means.[12]

a) Scientific-technological Model

Houses and Territory: A Flow Chart



Objectives

1. To develop students' awareness of some of the basic reasons for housing, such as, protection from the physical environment, need for space and territory, prestige, and social acceptance.
2. To develop students' awareness of the variety of materials used in house construction and of the stages of house construction.

11. M.R. Baker and R.L. Doran, "From An Awareness of Scientific Data to Concerns for Mankind: Strategies for Affective Instruction in Science". *Science Education*, 59(4), 1975.

12. Additional units which use this approach are "Skin and Clothes", "Petroleum", and "Solar Energy" from the Australian Science Education Project.

3. To apply students' understanding of principles of heat and sound; to teach students to evaluate the suitability of different building materials.
4. To develop students' knowledge of a variety of designs for houses and furniture and their relationship to people's needs and preferences.
5. To develop students' abilities to evaluate materials and designs.

The flow chart illustrates the application of scientific-technological principles and tests to the comparison and evaluation of heat and sound insulators, as well as to other building materials. It also illustrates that a theme may be used to examine designs for homes and the choice of a place to live. The latter topics begin to examine questions which may be resolved by collecting data and by comparing attitudes; at this point, students will begin to make value judgements. Such an extension represents a beginning for an issues approach.

Advantages

- Suggests to the student some of the interrelationships between science and the technologies and the possible effect of the interrelationships on him/her.
- Enables the teacher to pursue themes of interest to the student.
- Permits considerable flexibility in program development.

Disadvantages

- May require additional planning and development time in order to relate content and activities from a variety of support materials.
- Could lead to unbalanced scheduling of time in the six science disciplines.

b) Issues Model

The issues model can be developed as an extension of the examination of the interaction of science and technology. In addition, it can be used as a thematic approach relating scientific-technological information and the values used in applying the technology. For example, within the previously cited example "Houses and Territory", *heat conservation* can be related to the issue of the need for *energy conservation*, and *choosing a place to live* can be related to the issue of *housing preferences: the needs and values related to home ownership.*

Advantages

- Develops the skill of problem-solving.
- Promotes intelligent and informed action on the solution of personal and social problems.
- Uses a wide variety of instructional methods and examines various viewpoints.

Disadvantages

- Students may examine the same material in different grades.
- Grades 7-9 students have a limited experimental background ability with which to comprehend the many variables relative to an issue; thus, their solutions to complex problems may be facile and naive.
- This approach is time-consuming.

Restraint and caution are required because the approach and issues are complex and can become controversial.

Affective Taxonomy

Resolving issues involves both determining the interrelationships between problems and the variables contributing to these problems, as well as evaluating the variables and problems according to the values of the students. Because the value-systems of students are developing, it is necessary to understand the level at which a student may be operating. A taxonomy for the effective area, developed by Krathwohl et al[13], is useful for this purpose. The categories within the taxonomy and sample objectives related to the categories follow.

13. D.R. Krathwohl et al, *Taxonomy of Educational Objectives Handbook II: Affective Domain*, David McKay, New York, 1956.

category	*sample objective*
1. Receiving	
Awareness	Awareness that there are pesticides.
Willingness to receive.	Acceptance of the importance of pesticide control
Controlled or selected attention.	Sensitivity to the news about pesticides.
2. Responding	
Acquiescence in responding.	Willingness to read the assigned literature on pesticides.
Willingness to respond.	Voluntary acquaintance with the current uses of pesticides.
Satisfaction in response.	Enjoyment of discussing current uses of pesticides.
3. Valuing	
Acceptance of a value.	Feeling himself as a member of a group concerned with pesticide usage.
Preference for a value.	Assumption of an active role in controlling pesticides.
Commitment.	Loyalty to the "pesticide control" cause.
4. Organization	
Conceptualization of a value.	Development of a rationale about the use of pesticides.
Organization of a value system.	Formation of judgements reflecting beliefs that pesticides weaken the ecological system.
5. Characterization by a Value	
Value Complex Generalized set.	Viewing a problem from a multitude of vantage points.
Characterization. (Code of conduct and value system are internalized).	Development of a philosophy of life with environmental concerns related to pesticide use.

Some Techniques

Since the "issues" model may require the development of a wide variety of facts, concepts, and skills, a single approach cannot be defined within the limits of this guide. However, a number of general recommendations and techniques are suggested to help teachers who wish to attempt this approach. In general, the criteria that should be used in determining whether a situation may be of interest are: the learning and/or skills necessary to solve the problem should be specified by the teacher; the problem should be one that is both actual for and socially significant to the student. It should be noted that *what appears to be significant to the teacher may not be of concern to students.*

Relating Science Content to Values

Facts and principles developed in the science course can be related to questions concerned with students' lives and attitudes. A number of samples follow:

1. *Facts and Concepts*	*Values*
What are Newton's Laws of Motion? Using an experiment, demonstrate that you know these laws.	The use of seat belts in automobiles is directly related to one of these laws. Explain. Do you use them? Would you ever ride a motorcycle without a helmet? What other safety precautions do you take in everyday life?
Plants are primary producers.	Grass is difficult to maintain in a city; cities should be entirely asphalt paved. Do you agree or disagree? Give your reasons. If your community has a piece of wetland that could be left as is or drained and used for recreation, a jet port, or a place to dispose of junk cars, which would you prefer? On what basis would you make your decision?
Name three ways in which water can change the earth's surface.	Which of these would worry you at all or more than others? i) Converting the Delta Marsh into housing for senior citizens in that area. ii) Bulldozing a four lane highway through Riding Mountain? iii) Allowing cities to spread out over the earth's surface leaving less and less open space.

2. Another activity that may be used to begin to examine our value positions is represented by *An Electrical Survey*.

The skill area to be developed is "the ability to collect data". The material required is represented by the following form.

A Survey Form

Identify all the things in your home that use electricity and put them in the appropriate categories below.

1. We couldn't do without	2. Could do without with some difficulty	3. Are really not necessary

After the students have completed the form, the following questions can be used to form a basis for discussion:

- How many electrical uses did you list in column 1? What did people do before electricity was available?
- How much electricity does your home use in a day, month, year?
- How can you find out?
- Make a list of as many practical ways you can think of to decrease electrical consumption in your home. Try them to see if they work.

3. *Rank Ordering*

This technique can have many applications. Proposals and activites can be ranked in order of preference and a class profile can then be developed for anlaysis and justification. This activity may be more difficult than the preceding activities for students in grades 7-9 because it involves abstractions.

As a homeowner, whose cost of energy is increasing, I would:

- increase the insulation in my attic and walls and recoup the costs from the savings which will occur over the next few years;
- move to a warmer climate;
- go to the library in order to obtain more information concerning energy conservation;
- encourage my friends to form a home insulation company;
- plant trees as protection against the weather;
- form a group to lobby for lower energy costs;
- supplement the furnace with electrical base heaters;
- hope for strength in these tough times.

4. *Analysis*

This procedure may be used to provide practice in the skills of writing papers, preparing for debates, and analyzing issues. It may be used to conclude the study of a unit or as part of a student's research work.[14] Because this approach requires formal thinking skills, only the developmentally advanced students may benefit.

14. Baker and Doran. Another source of activities is William B. Stapp and Dorothy A. Cox, Environmental Education Activities Manual: Junior High Activities, 30808 Lamar, Farmington Hills, Michigan, 1974.

5. Selection of Materials

The texts and modules support rather than define the curriculum. In this revised course, the curriculum consists of the objectives of each unit as listed in the expanded outline. The materials are recommended as support to the students and teachers in developing the concepts or skills specified in the objectives. It is entirely feasible that the course could be taught without student copies of any of the materials. However, teacher copies of several of the recommended materials for each unit would be desirable.

The following pages should provide assistance to the teacher in selecting appropriate materials for use in the classroom and for teacher reference.

Page 20, "Alternative 1 — Modular Materials Supporting the Program" shows at a glance the primary recommended module(s) for each unit of each grade. Primary materials were selected as those which were most appropriate in most classroom situations for teaching a unit.

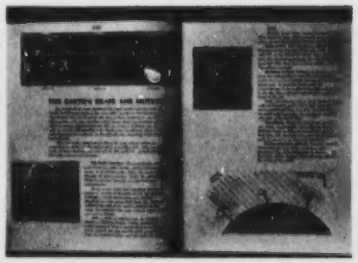
Specific use of each module is detailed in the expanded curriculum outline.

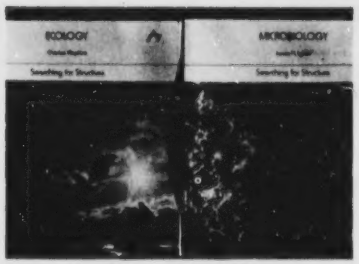
"Alternative 1 — Modular Materials Supporting the Program", page 20, "Alternative 2 — Additional Modular Materials Supporting the Program", page 21, and "Alternative 3 — Textual Materials Supporting the Program", page 22, indicate several other ways of covering the core objectives using modules and/or textbooks. Alternative materials may not relate as closely to the core objectives listed in the guide as do the primary materials. However, they may suggest different teaching emphases and offer different reading levels and student activities.

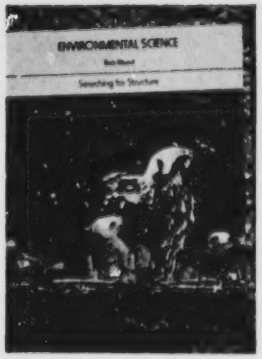
Appendix A, pages 111 to 115, is comprised of the annotations of each of the support materials recommended in this curriculum guide.

Appendix B, pages 117 to 124, is comprised of materials suitable for educationally disadvantaged students.

Appendix C, pages 125 to 129, includes suggestions for the teaching of topics in space science and includes a list of periodicals for use in the classroom or library.







ALTERNATIVE 1 — MODULAR MATERIALS SUPPORTING THE PROGRAM

	Environmental	Life	Earth	Space	Physics	Chemistry
Grade 7	**Focus on Science: Animals and Plants*[1]	**Focus on Science: Animals and Plants*[1] *Human Biology*	*Exploring Earth Science: Geology*	*Examining Your Environment: Astronomy*[1]	*Lab Inquiry Text: Measurement; Behaviour of Light and Sound; Methods of Science*	*Searching for Structure: Solids, Liquids and Gases*[1]
Grade 8	**Focus on Science: Microbes and Disease*	**Focus on Science: Animals and Plants*[1] *Human Biology*	*Exploring Earth Science: The Earth's Surface Geology*[1]	*Exploring Earth Science: Astronomy*[1]	*Searching for Structure: Heat and Electric Energy*	*Searching for Structure: Solids, Liquids and Gases*[1]
Grade 9	*Exploring Life Science: The Environment*	**Focus on Science: Reproduction and Heredity***	*Exploring Earth Science: The Atmosphere*	*Exploring Earth Science: Astronomy*	*Lab Inquiry Text:*[2] *Work, Energy and Simple Machines; Force and Motion*	*Searching for Structure: Structure of Matter*

* *Activity Centred Program: Teacher's Guide* is an essential support for all *Focus on Science* modules. One copy of *Life Science: A Learning Strategy for the Laboratory* is also desirable.

** The module *ASEP: Genetics* and the text, *Ideas and Investigations in Science: Life Science*, Wong et al are highly recommended as teacher references.

1. The superscripts indicate the modules are used in more than one grade.
2. Lab Inquiry Text (Physics) is not totally SI. The materials can be used as teacher reference. Units must be adapted by teachers.

ALTERNATIVE 2 — ADDITIONAL MODULAR MATERIALS SUPPORTING THE PROGRAM

Environmental	Life	Earth	Space	Physics	Chemistry
8 *Searching for Structure: Microbiology* 9 *Searching for Structure: Ecology*	8 *Exploring Life Science: The Human Body* 9 *ASEP:*[1] *Genetics*	7-9 *MAPS: Soil, Sea and Sky*	No Additional Modules	7 *Focus on Science: Measurement and Motion; Heat, Light and Sound* 8 *Focus on Science: Measurement and Motion; Electrical and Nuclear Energy* 9 *Focus on Science: Measurement and Motion* Note: *Activity-Centred Program: Teacher's Guide* is a good support.	7-9 *ASEP: Water* *ASEP: Energy and Change* *ASEP: Atoms* 7-9 *Exploring Physical Science: Chemistry*
Searching for Structure: Environmental Science	9 *MAPS:*[2] *Continuity of Life*	7-8 *Searching for Structure: Rocks, Minerals and Fossils* 9 *Searching for Structure: Weather and Climate*			7-9 *Science 5/13 Change: Stages 1 and 2, Stage 3* (teacher reference only)
		7-8 *Focus on Science: Earth's Matter and Origin; Erosion* 9 *Focus on Science: The Atmosphere and the Hydrosphere* Note: *Activity-Centred Program: Teacher's Guide* is an essential support.		7 *Lab-Inquiry Text: Physical Science; Measurement* *Exploring Physical Science: Heat, Sound and Light* 8 *Exploring Physical Science: Heat, Sound and Light; Electricity; Energy* 9 *Exploring Physical Science: Balanced and Unbalanced Forces*	7-9 *Focus on Science: Properties of Matter; Changes in Matter* Note: *Activity-Centred Program: Teacher's Guide* is an essential support. 7 *MAPS: Matter, Force and Motion* 8 *MAPS: The Physical World* 9 *MAPS: Matter, Force, and Motion* and *The Physical World*

1. *Australian Science Education Project.*
2. *Modular Activities Program in Science.*

ALTERNATIVE 3 — TEXTUAL MATERIALS SUPPORTING THE PROGRAM

Environmental	Life	Earth	Space	Physics	Chemistry
7-8 *Focus on Life Science: Activity-Centred Program: Teacher's Guide* is a good support OR *Life Science: A Problem Solving Approach* Plus *Exploring Life Science: The Environment* (a module)	7-9 *Focus on Life Science: Activity-Centred Program: Teacher's Guide* is a good support 7-8 *Life Science: A Problem Solving Approach* OR *IIS*[1]*: Life Science* plus module from Alternative 1 from Grade 9 modules	7-9 *Earth Science: A Search for Understanding* OR *Focus on Earth Science: Activity-Centred Program: Teacher's Guide* *Earth Science: A Learning Strategy for the Laboratory* (workbook) — not essential	7-9 *Earth Science: A Search for Understanding* OR *Focus on Earth Science* plus *Activity-Centred Program: Teacher's Guide* *Earth Science: A Learning Strategy for the Laboratory* (workbook) - not essential	7-9 *Focus on Physical Science: Activity-Centred Program: Teacher's Guide* OR *Physical Science: A Problem Solving Approach* OR *Exploring Physical Science*	7-9 *Science 5/13 Change: Stages 1, 2 and 3 Stage 3* (teacher reference only) OR *Exploring Physical Science* OR *Focus on Physical Science* Note: *Activity-Centred Program: Teacher's Guide* is an essential support. OR *Physical Science: A Problem Solving Approach*

1. *Ideas and Investigations in Science.*

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6. Student Evaluation

The Science 7-9 program, which develops concepts, processes, and skills by using an activity approach, requires continuous evaluation of the students. Such evaluation should help teachers understand their students' needs, indicate students' skills, attitudes and interests, and provide feedback on the effectiveness of the program. An evaluation system should use information gained from observation of the students in the classroom. Evaluation should indicate how a student best learns, specify student growth and achievements, and constantly recognize the goals and objectives of the science program.

The process of evaluating students should be closely related to the core and extension objectives of the curriculum. Evaluation should be a continuous, integral part of the teaching process and should not be restricted to the completion of a unit or term exam. Frequent and varied tests which pose a single problem, require a solution for an activity, request an explanation for a phenomenon, or the formulation of a hypothesis, all make possible the early adjustment of the program if difficulties are encountered. The unit or term exam can provide information about the cumulative aspects of the program and the development of long-term or general objectives. The following techniques for evaluation are suggested:[15]

- *Short answer questions:* This technique, consisting of a question that is answered by a word or phrase, often requires the process of recall, e.g., How many newtons does it take to support 3 kg at the earth's surface? _____
  What is the symbol for metres per second? _____

- *True — false questions:* This may require recall and recognition of facts and concepts, e.g., When iron is heated, its density increases. _____

- *Multiple choice questions:* This requires a selection of the best answer from a number of possibilities.

- *Interpretive exercises:* These exercises can measure a variety of objectives, including interpretations of laboratory experimentation and the processes of inquiry, e.g., Which one of the following graphs supports the hypothesis that the population on the earth will shortly reach a critical state?

- *Mathematical problem-solving:* Problem-solving using mathematical calculations can be an effective technique for evaluating both mathematical skills and the ability to organize and use related data.

- *Notes and reports:* Notebooks can contain the basic ideas that students are expected to understand. The nature of notes and reports expected by teachers should be made clear. In general, notes and reports should be well-organized with distinct and sequential headings, including important lists, diagrams, graphs, and summaries, and should be written grammatically and spelled correctly.

- *Projects:* These may take the form of written papers or working models. Students should be given the criteria which will be used in evaluation, e.g., Are the given data reliable and relevant?

- *Qualitative experiments:* These can be used to evaluate manipulative and behavioural performance such as safety precautions taken, efficient use of equipment, and experimental design. For example, students may be asked to observe, describe and compare everything that occurs when one half of an Alka-Seltzer tablet is dropped into cold water and the other half into warm water.

- *Quantitative experiments:* These add the dimensions of measurement and counting to the qualitative experiment.

- *Critical thinking:* This attempts to evaluate reasoning skills. Questions can be based on factual or fictitious statements and should promote students' attempts to relate cause and effect, to draw inferences, to distinguish fact from fiction, and to develop tentative conclusions, e.g., Answer the following questions basing your replies on the statement, "The use of penicillin produces bacteria that are resistant to penicillin."

  (i) What does this statement mean?
  (ii) What are the main consequences of this fact?
  (iii) What is the logical conclusion?
  (iv) How does this fact affect you?
  (v) How does it or will it affect your community?

Additional sources of information concerning methods and items of evaluation in science education are: William D. Hedges, *Testing and Evaluating for the Sciences in Secondary School.* Wadsworth Publishing Company, Belmont, California, 1966, and International Reading Association, *Improving Reading in Science.* International Reading Association, Newark, Delaware, 1976.

15. Many of the ideas were obtained from Ministry of Education (Ontario), *Intermediate Division Science.*

7. General Information of Interest to Administrators

Since the new program design for Science 7-9 provides a structure, a core, and flexibility in terms of extensions, teaching approach, and support materials, the school staff must examine it in order to determine the implications for their present science program, and to make decisions concerning the method of implementation. The role of the school administrator is critical in helping the staff with their deliberations.

ASSUMPTIONS CONCERNING PROGRAM DESIGN

- The core topics and objectives represent about 60% — 70% of the time of the total program.
- Extension objectives and activities are developed on the assumption that schools require differences in programming and emphases within a specific topic, e.g., consumer education.
- A general science approach rather than a discipline oriented program is more applicable to middle years students.
- Support materials should complement the approach used.

ROLE OF THE GUIDE AND SUPPORT MATERIALS

The curriculum guide, by defining a core set of topics and objectives, provides a basic program for grades 7-9. In addition, the guide provides a variety of extension objectives and activities with which schools can develop the program beyond core. Published materials have been recommended both on the basis of their support of core objectives as well as on the bases of reading level, approach used, and concept development. A natural starting place for the implementation of this guide would be to compare the program existing presently in the school with the one suggested in this guide; modification could then be made, where necessary, in the areas of student needs, approaches to science teaching, and support materials.

MATERIALS

Administrators should recognize that most textbooks are directed at specific age levels and may consequently present difficulties in comprehension if used with students at a lower age level. Alternatively, modules have a high per unit cost and can prove to be very expensive if used on a per student basis. However, experiences of pilot teachers using class sets of modules have shown that modules are reasonably durable, are flexible in their use, can be used in conjunction with materials presently in classroom, and, with cooperation among classes, can serve more than one class during a given year.

During the initial year of implementation, schools might consider supplementing textbooks currently in use with a limited number of modules, using alternative acceptable support materials, and preparing their own support materials and modules from selected chapters of old textbooks.

LABORATORY EQUIPMENT

Support materials have been chosen which require only simple laboratory equipment. Equipment generally available in grades 7-9 science laboratories will support the core program. However, no basic list of equipment is provided because the laboratory activities suggested in different materials may require a variety of equipment. Where materials have recommended non-standard equipment, alternate activities using simpler equipment can be readily located in other sources. Time will be required in order to organize this aspect of the program.

SUPPORTING STAFF DEVELOPMENT

A general science program requires a breadth of knowledge from different areas in science, although the depth requirements within core are not extensive. The degree of support needed for teacher development is dependent upon the rate of implementation and the assessment of school and teacher needs in terms of background, approach to be used, equipment, and materials.

INTRODUCTION OF SI

Schools should consider introducing SI in an integrated or coordinated manner within the mathematics, science, social studies, and other programs. Although correct use of SI in the published materials was an important criterion for selection, it was not always possible to obtain science materials which were totally SI. Teachers should refer to *Science Teacher's Guide to Metrication*[16] for help in converting the science program to SI. Additional information concerning the introduction and use of SI units within the science program is also found on pages 5 and 6 of this guide.

16. *Science Teacher's Guide to Metrication*, Department of Education, 1979.

One Possible Implementation Scheme

Depending upon the needs of the staff, on the material and equipment requirements, and on financial and other considerations, the time-frame for implementing the Science 7-9 program may vary from 2-3 years. A 3 year implementation program, as suggested below, will provide time for schools to assess needs, plan the nature and rate of implementation, and to develop teacher expertise. Implementation of a program in a 3 year period need not conflict with other priorities and needs of a school; rather, an implementation plan provides benchmarks which enable the school to determine both the effectiveness of the implementation process and any additional modifications necessary.

Year 1 (1979-1980)

Develop an awareness of the guide and its function.
Determine the role of science within the total program, approach(es) to be emphasized, and possible support materials.
Use new materials to implement one or two topics at each grade level.
Retain old texts; Thurber and Kilburn can be used to teach part of the program.
Obtain single copies of preferred new materials for examination purposes.
Make an inventory of laboratory equipment and determine equipment needs for the science program.
Organize laboratory support materials for one or two units.
Plan in-service needs and time-frame for implementation.

Year 2 (1980-1981)

Complete implementation of total program at the grade 7 level and continue with units previously implemented in grades 8 and 9.
Determine the nature of any in-services required.
Hold in-services concerning background, approach, SI.
Time specific in-services with the implementation of a specific area, e.g., space science in-service may occur slightly before this unit is developed.
Review time-frame for implementation and in-service needs.

Year 3 (1981-1982)

Complete implementation of grade 8 and grade 9 programs.
Hold in-services on specific subject, e.g., background or unit development.

OVERVIEW OF SCIENCE 7-9 CORE PROGRAM

	Environmental Science	Life Science	Earth Science	Space Science	Physics	Chemistry
Grade 7 Level 1	*Plants and Photosynthesis* 1. Plant Cell Structure and Function 2. Photosynthesis	*Biological Organization* 1. Microscope 2. Cells, Tissue, Organs 3. Organ Systems 4. Digestion	*The Earth* 1. Soil Characteristics 2. Introduction to Weathering and Erosion 3. Minerals	*Introduction to Space Science* 1. Looking at the sky 2. Solar System 3. Uniqueness of Space Science	*Introduction to Physics* 1. Measurement 2. Geometry of Light	*Investigating States of Matter* 1. States of matter 2. Water
Grade 8 Level 2	*Microbiology* 1. Bateria 2. Protozoans 3. Fungi	*Human Organ Systems* 1. Circulation 2. Respiration 3. Excretion	*Patterns in the Earth's Crust* 1. Weathering and Erosion 2. Classification of Rocks 3. Rock Cycle	*Earth, Moon and Sun* 1. Apparent Sky Motion 2. Describing Earth, Moon and Sun 3. Space Exploration	*Energy and Its Relationships* 1. Heat 2. Electrical	*Matter and Change* 1. Solutions 2. Physical and Chemical Change 3. Acids and Bases
Grade 9 Level 3	*Terrestial Ecology* 1. Abiotic and Biotic Relationships 2. Energy and Ecosystem 3. Succession	*Reproduction and Heredity* 1. Sexual, Asexual 2. Mammalian Reproduction OR 3. Genetics	*Weather* 1. Elements of Weather 2. Interaction of the Elements of Weather 3. Weather Patterns and Forecasting	*The Universe* 1. Astronomical Instruments 2. Studying Objects in space	*Force, Work and Motion* 1. Force and Motion 2. Work 3. Machines	*Chemical Interactions* 1. Classifying Matter 2. The Atom - Model for Matter 3. Chemical Interactions 4. Conservation of Matter

SCOPE AND SEQUENCE

CORE OBJECTIVES — GRADE 7

	Environmental Science	Life Science	Space Science
Concept Objectives	The student should be able to: 1. Describe the structure and function of the major parts of a plant cell: a) cell membrane, b) vacuole, c) nucleus, d) nuclear membrane, e) cytoplasm, f) chloroplast, g) cell wall. 2. Identify the major structural parts of leaves and relate structure to function: a) upper and lower epidermis, b) palisade layer, c) chloroplasts, d) spongy layers, e) vein, f) stomata, g) guard cells. 3. Define transpiration. 4. Describe the interaction between chlorophyll, carbon dioxide, and the sun's energy in the process of photosynthesis.	The student should be able to: 1. Identify and describe the structure of major parts within the animal cells (human cheek): a) cell membrane, b) cytoplasm, c) nucleus. 2. Compare the structure and function of major parts within the plant and animal cells. 3. Distinguish between cells and tissues. 4. Distinguish between the structure and function of animal tissues: a) muscle, b) skin, c) blood, d) bone. 5. Describe the structure and function of sample organs: a) heart, b) kidney. 6. Distinguish between organs and organ-systems. 7. Describe the structure and function of organ-systems: a) digestive, b) circulatory, c) respiratory, d) nervous, e) skeletal, f) endocrine. 8. Compare the structure and function of the digestive system in the earthworm and frog.	The student should be able to: 1. Describe the positions and movement of celestial objects which can be observed and predicted through the use of instruments such as the astrolabe and/or sky maps. 2. Describe the effect of the earth's movement upon the sun's position relative to the earth. 3. Illustrate the motions of the moon and the earth around the sun over a period of several months. 4. Be aware of the uniqueness of space science among the sciences. Space science is primarily observational rather than experimental. Observations are limited by great distances and the sizes of interacting objects. Major advances are dependent upon new observational techniques.

CORE OBJECTIVES — GRADE 7

	Environmental Science	Life Science	Space Science
Process Objectives	The student should be able to: 1. Observe and compare plant and animal cells using a microscope. 2. Test for carbon dioxide, water, and starch. 3. Record the data relating the effect of removing sunlight upon the production of starch by plants. Infer the relationships. 4. Describe how one would support the hypothesis that plants cannot produce starch without light, water, or carbon dioxide.		The student should be able to: 1. Observe and record data concerning the position of: a) stars, b) the sun over a period of a month. 2. Construct a model of the solar system.
Psychomotor Skills	The student should be able to: Demonstrate the proper use and handling of a microscope: a) Focus a microscope; b) Estimate the size and field of objects; c) Prepare wet mounts.	The student should be able to: 1. Use microscope skills as defined within environmental science. 2. Use dissection skills (earthworm and frog).	The student should be able to: 1. Use an astrolabe to specify the position of some celestial objects: a) stars, b) sun by indirect observation.

CORE OBJECTIVES — GRADE 7

	Earth Science	Physics	Chemistry
Concept Objectives	The student should be able to: 1. Describe such characteristics of soil as particle size, hardness, water absorption, percolation, and capillarity. Soils can be classified on the basis of the above characteristics. 2. Distinguish between weathering and erosion. a) Distinguish between physical and chemical weathering. b) Distinguish between erosion by weather and wind. 3. Define a mineral and compare a variety of minerals in terms of hardness, colour, lustre and other characteristics. 4. Discuss the economic and aesthetic values associated with soil, weathering, and erosion.	The student should be able to: 1. Explain and cite practical examples of the reflection of light from plane surfaces: a) light travels in straight lines, b) the angle of an incident ray equals the angle of a reflected ray. 2. Explain and cite practical examples of the refraction of light from plane surfaces: a light ray entering or leaving a medium (other than 90° to the medium) will be bent.	The student should be able to: 1. Define, in terms of heat requirements, the processes by which matter changes from one state to another: a) evaporation, b) boiling, c) condensation, d) melting, e) freezing. Each state of matter has identifiable characteristics. 2. Compare the effect of temperature upon the rate of evaporation of water. 3. Compare the evaporation rates of different liquids. 4. Describe a test for water. 5. Describe the effect of cooling on water vapor (condensation). 6. Relate temperature change to change of state: a) melting and freezing, b) boiling. Relate changes of state to the water cycle and describe the importance of the water cycle to life on earth. 7. Cite evidence that supports the concept that matter is composed of moving particles (molecules) which have spaces between them. 8. Explain on the basis of molecules and their motion, the states of matter and changes in state.

CORE OBJECTIVES — GRADE 7

	Earth Science	Physics	Chemistry
Process Objectives	The student should be able to: 1. Classify and test soil samples for characteristics such as particle size and water absorption. 2. Identify soil organisms other then micro-organisms. 3. Test and compare a variety of minerals according to hardness, colour and other characteristics.	The student should be able to: 1. Develop competence in measuring length (m, cm), mass (g, kg), area (cm^2, m^2) and volume (cm^3, mL). 2. Observe and record paths of light from a plane mirror and infer general principles of reflection. 3. Observe the path of light through a glass plate and compare the angle of entry to the angle at which light leaves the medium. 4. Use diagrams to describe interactions of light with plane surfaces.	The student should be able to: 1. Classify given materials in terms of the three states of matter. 2. Graph evaporation rates of a liquid at different temperatures and infer the relationship between temperature and evaporation rate. 3. Graph temperature change versus time for the processes of melting and boiling. Infer the relationship between heat requirements and a change of state.
Psychomotor Skills		The student should be able to: 1. Perform measurements in length, area, volume, mass, and time using SI terminology. 2. Measure angles.	The student should be able to: 1. Measure temperature in degrees Celsius. 2. Measure volume in millilitres.

CORE OBJECTIVES — GRADE 8

	Environmental Science	Life Science	Space Science
Concept Objectives	The student should be able to: 1. Identify bacterial cultures (drawings or prepared slides) as coccus, spirillus, or bacillus. 2. Describe the characteristics of protozoans. 3. Describe the nutrition requirements of bacteria. 4. Differentiate between protozoans as ciliates or flagellates. 5. Describe the requirements necessary for culturing bacteria. 6. Differentiate between bacteria on the basis of parasitism or saprophytism. 7. Describe the process of fermentation and compare the effect of different factors upon the growth rate of yeast cells. 8. a) Identify the characteristics of a mold, a yeast, a mushroom, a puffball. b) Point out the similarities and differences in structure and function of the following pairs of organisms: i) mold-yeast, ii) mushroom-yeast, iii) mold-mushroom. 9. Describe the role of bacteria and fungi as decomposers.	The student should be able to: 1. Define diffusion and its role in keeping a cell alive. 2. Describe the structure and function of parts of the human circulatory system: a) heart, b) arteries and veins, c) capillaries, d) blood. 3. Describe the structure and function of parts of the human respiratory system: a) diaphragm and ribs, b) alveoli. 4. Relate the roles of the respiratory system to the circulatory system. 5. Describe the structure and function of parts of the human digestive system: a) mouth, b) stomach, c) small and large intestine, d) pancreas, e) liver. 6. Describe the structure and function of various parts of the human excretory system: a) lungs, b) kidneys, c) skin.	The student should be able to: 1. Describe the apparent motion of sky objects during the day and night. 2. Describe and cite evidence of motions of the earth and its interaction with the sun. 3. Describe experiments and other evidence used to determine the size and shape of the earth. 4. Describe the shape, motions, and other characteristics of the moon and its interaction with the earth. 5. Describe some of the moon flights and the information they produced. 6. Discuss the merits of space flight. Data not available using earth-based instruments can be obtained from space vehicles. 7. Describe some of the basic characteristics of the sun. The sun is a typical star whose nature can be determined from solar radiation. 8. Describe the contributions of space scientists. Our systematic understanding of the earth and space has been increased by the contribution of space scientists in areas such as navigation.

CORE OBJECTIVES — GRADE 8

	Environmental Science	Life Science	Space Science
Process Objectives	The student should be able to: 1. Classify bacteria on the basis of structure. 2. Observe and record the characteristics of protozoa such as paramecia. 3. Describe variables which affect the growth of yeast cells. 4. Infer the relationship between the growth of a yeast culture and variables such as temperature and the growth medium. 5. Given a graph relating bacteria growth to temperature, describe the best temperature conditions for: a) growth, b) preventing growth. 6. Suggest factors which affect the rate of growth of molds and a method of controlling variables in order to determine relationship between growth and one factor, e.g., moisture.	The student should be able to: 1. Observe and describe the movement of blood through the capillaries of an animal. 2. Measure and record rate of heart beats before and after activity. Graph rates of heart beat within a class and compare rates.	The student should be able to: 1. Use models to explain phases and eclipses of the sun and moon in terms of the relative motion of the earth, sun, and moon.
Psychomotor Skills	The student should be able to: 1. Observe cultures of protozoa under a microscope. 2. Measure temperature in degrees Celsius.		

CORE OBJECTIVES — GRADE 8

	Earth Science	Physics	Chemistry
Concept Objectives	The student should be able to: 1. Determine and use terms associated with weathering and erosion (talus, bedding, angle of rest, sediments, suspensions, oxbows, deltas, alluvial fan, meandering stream). 2. Describe some of the physical and chemical processes by which rocks "weather". Compare the effects of physical and chemical processes upon rock structure. 3. Describe how wind and water influence erosion: a) compare the factors which affect erosion of landforms, b) describe local landforms which are changed by agents of erosion and explain the effects of wind, running and ground water. 4. Describe and compare the characteristics and formation of igneous, sedimentary, and metamorphic rocks: a) igneous rocks were initially formed by the cooling magma of the earth, b) sedimentary rocks are formed by deposition and/or erosion, c) metamorphic rocks are reconstituted from sedimentary and igneous rocks. 5. Diagram and describe the cyclic nature of rock formation.	The student should be able to: 1. List various energy forms and give an example of work done by each. 2. Describe how mechanical, chemical, and electrical energy may be converted into heat. 3. Describe the effects of heat energy on matter in terms of property changes (size, state, electrical conductivity, chemical change). 4. Demonstrate and describe the transformation of forms of energy (chemical, mechanical, light, heat) to electrical energy. 5. Compare the effects of electric current (energy) on various solids and liquids (conductors and non-conductors).	The student should be able to: 1. Define the terms: a) soluble, b) insoluble, c) suspension, d) dissolve, e) solution. 2. Compare the solubility of some substances in water. 3. Describe methods of separating dissolved and undissolved particles from a mixture or solution. 4. Distinguish between a physical and chemical change and describe the identifying characteristics of each. 5. Distinguish between endothermic and exothermic reactions. 6. Identify physical and chemical changes that occur in one's environment. 7. State the general identifying characteristics of acids and bases.

CORE OBJECTIVES — GRADE 8

	Earth Science	Physics	Chemistry
Process Objectives	The student should be able to: 1. Experiment with stream flow variables which affect erosion. 2. Identify and classify examples of the three rock types on the basis of characteristics such as texture and mineral content.	The student should be able to: 1. Observe and record methods of producing heat and the effects of heat upon matter (change of state, size). 2. Observe and record methods of converting energy from one form to another.	The student should be able to: 1. Observe, record, and compare the solubility of some solids. 2. Infer the effect of size of particles upon dissolving rate. 3. Test for oxygen and carbon dioxide. 4. Observe and record some chemical changes on the basis of colour and weight changes and tests for product changes. 5. Operationally define acids and bases. 6. Classify acids and bases on the basis of tests.
Psychomotor Skills		The student should be able to: 1. Demonstrate skill in the use of a thermometer.	The student should be able to: 1. Measure mass in grams and decimal fractions of grams. 2. Practice safety procedures in the use and heating of certain chemicals.

CORE OBJECTIVES — GRADE 9

	Environmental Science	Life Science	Space Science
Concept Objectives	The student should be able to: 1. Differentiate between abiotic and biotic factors in a terrestrial ecosystem. Describe their interaction. 2. Identify biotic relationships existing in a specific ecological community as: a) competition, b) parasitism, c) mutualism, d) commensalism, e) predation. 3. Differentiate between habitat and niche. Qualify the niche and habitat of animals and plants from a specific ecosystem. 4. Identify biotic relationships or roles existing within a specific ecosystem as: a) producers, b) consumers, c) reducers - saprophytes, d) scavengers. Relate adaptive structures of an organism to success. 5. Define energy and biomass. 6. Trace the energy flow through a food chain and relate it to the pyramid of biomass (energy). 7. Apply the concept of energy loss within a food chain to a specific problem, e.g., given a one month's supply of corn and wheat seed, and chickens on an island, describe how one would best utilize the plants and animals in order to survive. 8. Identify changes in populations (succession) within a specific ecosystem such as an untended lawn or an aquarium.	The student should be able to: 1. Differentiate among four kinds of asexual reproduction: a) budding, b) meitosis, c) binary fission, d) regeneration. 2. Compare the effects of asexual and sexual reproduction upon the characteristics of new cells. 3. Describe the relationship of each of the following terms to the development of an organism: a) sperm, b) testis, c) ovary, d) gamete, e) fertilization, f) zygote. 4. Compare reproduction in simple organisms, (e.g., paramecium) with multi-cellular organisms (e.g., fish). *CORE A (Mammalian Reproduction)* 1. Describe relationships within the estrus cycle. 2. Describe how mammals feed their new born. *CORE B (Genetics)* 1. Identify variations or traits within a population of a specific organism (e.g., peas) and humans. 2. Identify chromosomes and genes and relate their role in inheritance of traits. 3. Distinguish between a dominant or recessive trait and relate the effect upon a characteristic when: a) only dominant, b) only recessive, c) both are present. 4. Discuss meiosis and fertilization and relate to Gene Theory. 5. a) Describe a procedure (pencil and paper) for solving genetic problems. b) Solve genetic problems involving single dominant and recessive traits.	The student should be able to: 1. Describe some of the characteristics of the objects in the solar system: sun, planets, moons, planetoids, comets, meteors. 2. Use or describe the use of the telescope, camera, and spectroscope in investigating objects in space. 3. Describe some of the characteristics of galaxies (including the milky way), variable stars, novas and supernovas, binary stars, star clusters, nebulae, quasars, neutron stars, black holes. Matter is concentrated in different forms within the universe. Some observed data has raised new questions about the origin of the universe. 4. Explain the statement "We are the stuff of stars". Observations of present and past activities within the universe have led to theories concerning the origin of the universe. One such theory is the Big Bang Theory.

CORE OBJECTIVES — GRADE 9

	Environmental Science	Life Science	Space Science
Process Objectives	The student should be able to: 1. Operationally define light measurement and pH. 2. Record the effect of light or pH upon the success of organisms in an aquarium or similar ecosystem.	The student should be able to: *CORE B (Genetics)* 1. Formulate a model for describing the transmission of traits in sexual reproduction. 2. Predict the probable traits of an offspring for a single characteristic, given the genotype of parents.	The student should be able to: 1. Construct a scale model of the solar system. 2. Hypothesize the effects upon observations from the earth if the sun-earth-moon system were not moving

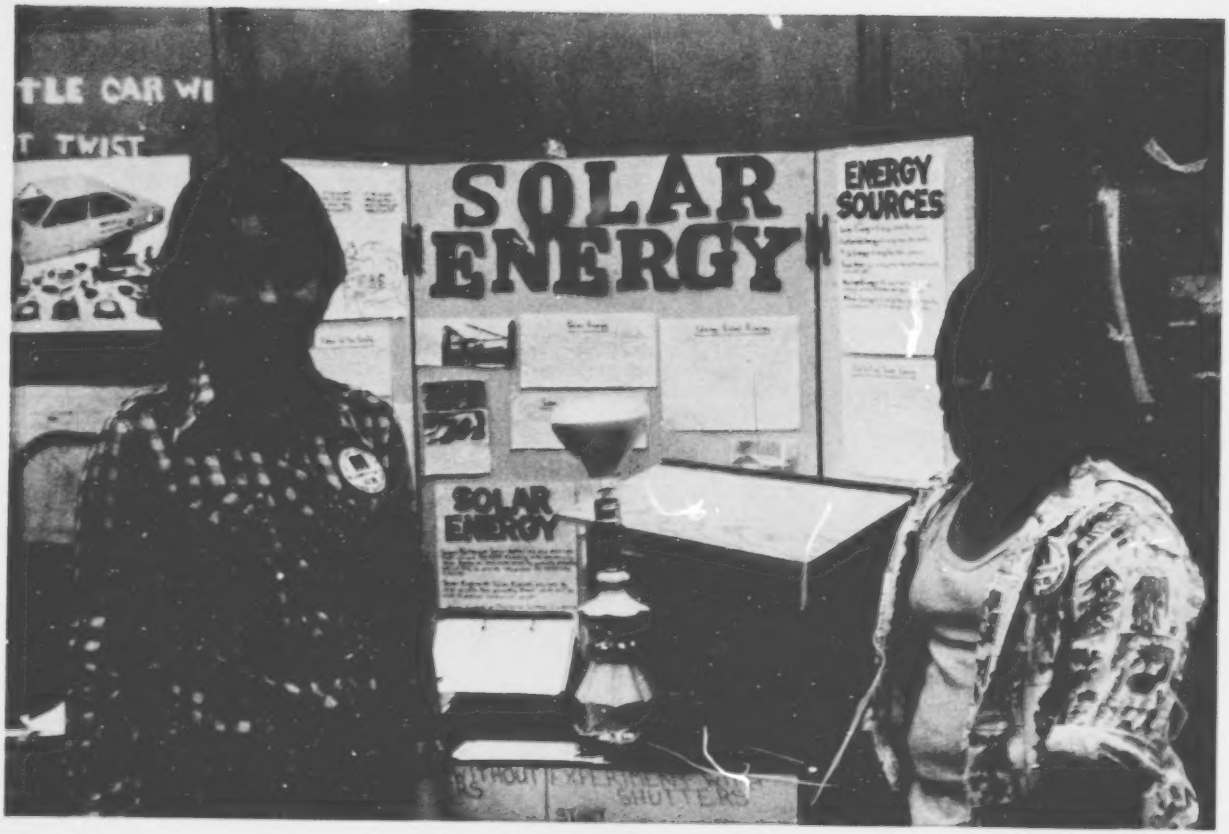
CORE OBJECTIVES — GRADE 9

	Earth Science	Physics	Chemistry
Concept Objectives	The student should be able to: 1. Define and use terms associated with weather (conduction, convection, radiation, saturation, land-breeze, dew point, relative humidity, warm front, cold front, air mass). Solar energy is absorbed by the earth. Heat absorption varies and is distributed by a number of mechanisms. 2. Define and explain the use of a barometer, wet-and-dry bulb thermometer, hygrometer, and anemometer. Instruments may be used to measure variables within air masses. 3. Describe how clouds are formed and identify three major types of clouds. 4. Describe what happens when a warm front meets a cold air mass and when a cold front meets a warm air mass. 5. Describe the effect of weather and climate on lifestyles.	The student should be able to: 1. Describe the relationship between a force and motion: a) an unbalanced force produces motion, b) motion is related to and occurs in the direction of an unbalanced force. 2. State the relationship between force, distance, and work. Identify when work has been done, given various situations. 3. Describe the "Law of the Lever". 4. Determine and describe the mechanical advantage for each of the three classes of levers and the inclined plane.	The student should be able to: 1. State the general identifying characteristics of: a) mixtures (solid-solid) and solutions (solid-liquid), b) elements, c) compounds. 2. Compare elements and compounds to mixtures. 3. Compare methods and characteristics used in separating mixtures. 4. Distinguish between synthesis and decomposition occurring within chemical reactions. 5. Identify the main statements of atomic theory and define basic terms associated with the atomic model of matter. 6. Compare atoms and molecules. 7. Describe simple chemical reactions using word equations. 8. State the Law of Conservation of Matter and apply the law to systems of chemical reactions.

CORE OBJECTIVES — GRADE 9

	Earth Science	Physics	Chemistry
Process Objectives	The student should be able to: 1. Record and organize weather data over a period of months. 2. Forecast the weather on the basis of observation and other recorded data.	The student should be able to: 1. Measure forces in newtons. 2. Investigate how a first class level multiplies force. Record effort and resistance when the relationship between force and resistance arms are controlled in simple ratios (1:1, 2:1, 3:1, 1:2); compare and interpret the relationships. 3. Graph and interpret data relating the effort and resistance in second and third class levers. 4. Record and interpret the data relating effort, resistance, and slope of an inclined plane.	The student should be able to: 1. Construct models of simple molecules (e.g., water, carbon dioxide). 2. Infer that matter is conserved in a chemical reaction.
Psychomotor Skills	The student should be able to: 1. Demonstrate the use of various weather instruments such as the thermometer, barometer, and anemometer.	The student should be able to: 1. Measure forces using a spring scale and distances using a metre stick.	The student should be able to: 1. Separate a mixture by the process of filtration. 2. Measure mass in grams and decimal fractions of grams using a balance scale.

GRADE 7



ENVIRONMENTAL SCIENCE — PLANTS AND PHOTOSYNTHESIS

Rationale: The continuation of life on earth is dependent upon converting energy from the sun into materials that are usable by living organisms. The intermediary in this process is the plant, a primary producer. Interactions among organisms and the distribution and limitations of populations are ultimately dependent upon limiting factors in the environment and the ability of plants to convert energy. It is recommended that this unit be done early in the fall.

Objectives	Activities	Materials
The student should be able to:		
1. (a) Name and identify the parts of the compound microscope: ocular, objectives, stage, coarse and fine adjustment, diaphragm, condenser, mirror.	(a) Demonstrate and discuss the function of microscope parts.	(a) Any standard biology lab manual.
(b) Explain the functions of the above parts.	(b) Demonstrate and discuss the function of microscope parts.	(b) Any standard biology lab manual.
(c) Estimate size and field of objects.	(c) Lab: Have students observe a plastic metric ruler under various powers and have students estimate the size of human hair.	(c) No reference.
(d) Prepare wet mounts.	(d) Prepare a wet mount and focus a microscope correctly.	(d) *Focus on Life Science: Activity Centred Program; Teacher's Guide* — one copy for teacher reference is required if *Focus on Science* is used as a reference.
(e) Focus a microscope.	(e) Prepare a wet mount and focus a microscope correctly.	
Do not repeat if microscope was studied previously.	Lab: The microscope.	(a) — (d) *Life Science: Learning Strategy for the Laboratory*. "The Magnificent Microscope" (Lab 14).
2. (a) List the major parts of a plant cell: cell membrane, vacuole, nucleus, nuclear membrane, cytoplasm, chloroplast and cell wall.	(a) Research assignment based on primary reference: *Focus on Science: Animals and Plants*	(a) *Focus on Science: Animals and Plants:* Cell Theory (Section 2:2); Cell Structure (Section 2:3); Plant Cells (Section 4:7).
(b) Describe the function of each structure mentioned above.	(b) Lab: Observation of onion skin cells, algae cells, and elodea cells.	(b) *Focus on Life Science: Activity Centred Program; Teacher's Guide* *Life Science: Learning Strategy for the Laboratory* (Lab 15).

Objectives	Activities	Materials
3. (a) Describe the process of photosynthesis.	Class demonstrations or labs: (a) Photosynthesis and starch production;	*Focus on Science: Animals and Plants* (Chapter 5). (a) *Focus on Life Science: Activity Centred Program; Teacher's Guide.*
(b) Explain the roles of chlorophyll, carbon dioxide and water in the photosynthesis reaction.	(b) Photosynthesis and carbon dioxide;	(b) *Focus on Life Science: Activity Centred Program; Teacher's Guide.*
(c) Describe the importance of light in food production by plants.	(c) Rate of photosynthesis.	(c) *Focus on Life Science: Activity Centred Program; Teacher's Guide.*
	(d) Student labs: (i) Grow plants in enriched carbon dioxide atmosphere; (ii) Grow elodea in light and dark areas.	(d) *Life Science: Learning Strategy for the Laboratory* (Labs 24 and 25).
4. (a) Identify the upper and lower epidermis, palisade layers, chloroplasts, spongy layers, vein, stomata, guard cells.	(a) Activity 2: Structures and functions of parts of a leaf.	(a) *Searching for Structure: Plants;* one copy per teacher is recommended. *Focus on Science: Animals and Plants* (Section 4:6).
(b) Relate leaf structure to function.	(b) Activity 2: Structures and functions of parts of a leaf.	(b) *Searching for Structure: Plants;* one copy per teacher is recommended. *Focus on Science: Animals and Plants* (Section 4:6).
(c) Define transpiration.	(c) Lab I: Transpiration. Lab II: Transpiration; Loss of Water by Plants.	(c) *Focus on Life Science: Activity Centred Program; Teacher's Guide.* *Searching for Structure: Plants* (Section 2:5).
Extensions		
1. Classify a plant as an algae, fungus, moss, or vascular plant.	(a) Assign classification as a research project. Students are to list characteristics for each group.	(a) *Focus on Science: Animals and Plants:* Mosses and Liverworts (Section 4:1); Ferns (Section 4:2); Seed Plants (Section 4:3).
	(b) Have students bring plant samples to class. Large or small group then classifies the plants.	(b) *Searching for Structure: Plants.*

Objectives	Activities	Materials
Extensions (cont'd)		
2. (a) Define the function of the following vascular plant organs: (i) roots; (ii) stems.	(a) Have students identify root parts from prepared cross-section slides.	(a) *Focus on Science: Animals and Plants* (Section 4:4).
(b) Identify the various structures of the above organs: (i) Define and identify root structures: epidermis, phloem, xylem; (ii) Define the types of roots and their functions.	(b) Lab: Kinds of Root Systems.	(b) *Searching for Structure: Plants* (Section 2:1).
3. Determine the effect of different parts of the light spectrum upon food production.	Have students grow bean plants in containers covered with different coloured cellophane. Students record stem length, diameter, leaf dimensions over a period of time. Results can be graphed.	
4. Examine the behaviour of root growth in response to gravity: geotropism.	Lab: (a) Effect of gravity upon seedlings grown in different directions.	(a) *Focus on Life Science: Activity Centred Program: Teacher's Guide.*
	(b) Start bean seeds in various directions. Determine the direction of root growth.	(b) *Life Science: Learning Strategy for the Laboratory* (Lab 21).
5. Examine the behaviour of root growth in response to water: hydrotropism.	Lab: Moisten a ball of sphagnum moss and place seeds around the ball. Hang and keep moist.	*Focus on Life Science: Activity Centred Program; Teacher's Guide.*
6. Identify a plant using a simple botanical key.	Have students bring in sections of common woody plants. Use "Field Guide to the Native Trees of Manitoba".	*Field Guide to the Native Trees of Manitoba.* — E.T. Oswald and Frank H. Nokes (Available free from Manitoba Department of Agriculture).

Objectives	Activities	Materials
Extensions (cont'd)		
7. Extract, separate, and identify pigments found in plants using the process of chromotography.	Shred leaves into a test tube. Cover leaves with alcohol and heat in a hot water bath to remove pigment (Caution: Refer to page 53 *Safety in Science for Manitoba Science Teachers*). Decant extract into a clean test tube and insert 2.5 cm x 14 cm folded strips of blotting paper into test tube. Observe after a few hours.	
8. (a) Identify and classify fruits as simple or aggregate, fleshy or dry, a pome, berry or drupe, dehiscent or indehiscent.	(a) Lab: Identify and classify various fruits. Students can bring fruit samples to class, or	*Searching for Structure. Plants* (Chapter 4).
(b) Differentiate between the above terms.	(b) Visit a supermarket and have students classify fruits.	
9. (a) Identify the structure of a simple flower.	(a) Obtain and dissect simple flowers (discards from a florist).	
(b) Describe the function of: petals, stamens, anther, pistil, ovary, stigma, style, receptacle, sepals.	(b) Research and report on the functions of parts of a flower.	
(c) Differentiate between a simple flower and a composite flower.	(c) Dissect a composite flower.	(c) *Searching for Structure: Plants* (Chapter 4). *Focus on Life Science: Reproductions and Heredity* (Chapter 2).

LIFE SCIENCE — BIOLOGICAL LEVELS OF ORGANIZATION

Rationale: A study of biology is vital if a student is to understand his physical development, his peers and his environment. This section introduces the microscope which is the basic tool for developing an appreciation and understanding of animal cells, tissues and organ systems. An understanding of animal systems forms the basis for the study of human systems and heredity in grades 8 and 9.

Objectives	Activities	Materials
The student should be able to:		
1. (a) Identify parts of a microscope.	(a) Demonstrate and discuss the function of microscope parts.	(a) — (e) *Focus on Life Science: Activity Centred Program; Teacher's Guide* or any standard biology lab manual or *Life Science: Learning Strategy for the Laboratory* (Lab 14).
(b) Describe the functions of each microscope part.	(b) Demonstrate and discuss the function of microscope parts.	
(c) Construct a wet mount slide.	(c) — (e) Demonstrate the construction of a wet mount slide. Have students construct wet mount slides and focus a microscope. Teacher may use microprojector, if available, to demonstrate technique and assist in interpretations. This applies to all objectives of this unit.	
(d) Focus a microscope.		
(e) Interpret observations.		
Do not repeat if microscope is studied in *Plants and Photosynthesis.*		
2. Identify the cell structures found in human cheek cells: cell membrane, cytoplasm, nucleus.	Have students identify cell parts using the microscope.	*Life Science: Learning Strategy for the Laboratory* (Lab 15) or *Focus on Life Science: Animals and Plants* (Section 22).
3. Discuss the function of the following cell parts: cell membrane, cytoplasm, nucleus.	Show functions of each of these cell parts using diagrams.	*Focus on Life Science: Animals and Plants* (Section 2:3).
4. State the differences between a plant cell and an animal cell.	Carry out this activity only if the topic Plants and Photosynthesis has been studied; student can research this topic by referring to Plant and Photosynthesis unit. Teacher to emphasize major difference between the structures of plant and animal cells. Chloroplast, cell wall and water vacuole are structures found in plant cells.	Refer to Plants and Photosynthesis: Objective No. 2, in Environmental Science unit.

Objectives	Activities	Materials
5. Distinguish between cells and tissues.	Teacher led discussion. Set up a microscope demonstration of various tissue slides found in your laboratory. Have students arrive at a tissue definition.	*Focus on Life Science: Animals and Plants* (Section 2:1).
6. Distinguish between the structure and function of various animal tissues: muscle, skin, blood, bone.	Teacher demonstration of various tissues if there are a limited number of slides or student can do full lab if class slides are available.	*Focus on Life Science: Animals and Plants* (Section 2:1). Refer to *Activity Centred Program: Teacher's Guide* for activity assistance.
7. Distinguish between organs and organ systems.	Have students research differences. Discuss.	*Focus on Life Science: Animals and Plants* (Sections 1:2 and 1:3).
8. State examples of organs and their functions.	Discussion. Have students bring organ samples such as pig's heart or kidney.	*Focus on Life Science: Animals and Plants* (Sections 1:2 and 1:3).
9. State examples of organ systems and their functions.	Discuss digestive, circulatory, respiratory, nervous, endocrine and skeletal systems. Note: (a) Discuss in terms of function only. (b) Discuss each system only briefly.	*Focus on Life Science: Animals and Plants* (Sections 1:2 and 1:7).
10. Compare and contrast the structure and function of the digestive system in an earthworm and a frog.	These two organisms are readily available. Laboratory exercise should be done to supplement discussion and research. Emphasize the similarities of frog systems to those of humans.	*Life Science: Learning Strategy for the Laboratory.* *Focus on Life Science: Animals and Plants* (Section 1:2).
Extensions		
1. Study chemistry of foods:		
(a) Analyze a given food for the presence of sugar, starch, fat, and vitamin C.	(a) Demonstrate to the students the simple tests for each of the following nutrients: sugar — Benedict's test; starch — iodine test; fat — brown paper test; vitamin C — indophenal test. Have students run the four tests on a sampling of foods brought from home.	(a) *Focus on Science: Activity Centred Program; Teacher's Guide* (Chapter 4).

Objectives	Activities	Materials
Extensions (cont'd)		
(b) Measure the amount of water in a food.	(b) Weigh a sample of string beans or any similar food. Cut into small pieces and allow to air dry (low heat in an oven for 24 hours will suffice). Reweigh the sample and have students calculate the amount of water loss. Calculate the percentage of water in the food.	(b) No reference.
(c) Compare the percentage of water content of different foods and illustrate the data on a bar graph.	(c) Repeat above but give each group in the class different food. Compile the results.	(c) No reference.
(d) Describe the function of each nutrient in the body. The following nutrients should be discussed: water; minerals; carbohydrates; sugars; starch; glycogen; fats and oils; proteins; vitamins.	(d) Have students prepare a written report on the role of each nutrient in the body, construct a chart which summarizes the role of nutrients in the body, or make oral presentations to the class on the function of each nutrient.	(d) Library references.
(e) Describe the following diseases that result from diets lacking specific nutrients: scurvey, rickets, beriberi, goiter, kwasiorkor.	(e) For each disease, have the student research the nutrient deficiency and the symptoms. This activity can be handled as described in section (d).	(e) Library references.
(f) Predict the effect of heat on vitamin content in food with the use of a graph.	(f) Have students heat sample of fresh orange juice to different temperatures. Test each sample for vitamin C using indophenol. Students can then plot the results on a graph.	(f) No reference.
2. Discuss structure and function of the circulatory system components of: earthworm, fish, amphibian (frog), mammalian (beef or pig).	Discuss and dissect, where possible, to illustrate the circulatory system.	*Focus on Science: Animals and Plants* (Section 1:3). *Focus on Science: Activity Centred Program: Teacher's Guide.*
3. Discuss structure and function of respiratory system components of: grasshopper, crayfish, amphibian (frog), mammal (beef or pig).	Discuss and dissect, where possible, each of the animal components.	*Focus on Science: Animals and Plants* (Section 1:4). *Focus on Science: Activity Centred Program; Teacher's Guide.*

EARTH SCIENCE — THE EARTH

Rationale: The grade 7 student begins earth science studies by learning about one of the major elements of the environment, namely, the soil. The topic includes the study of minerals and the observation of the effects of weathering and erosion on the soil. It is important to recognize that most grade 7 students are operating at a concrete stage; therefore, the processes of observation, classification, identification, and measurement should receive considerable emphasis. Field study and laboratory skills should be stressed.

Objectives	Activities	Materials
The student should be able to:		
1. Describe such characteristics of soil as particle size, hardness, absorption of water, percolation, and capillarity.	Collect soil samples and examine them in terms of stickiness, particle size, and percentage of organic matter.	*Exploring Earth Science: Geology* (Chapter 3) or *MAPS: Soil, Sea, and Sky* (Chapter 7)
2. Describe and use a method for identifying different kinds of soil.	Classify and test the soil samples according to the above characteristics. Examine soil layers on site, identify the layers, and measure their thicknesses.	*Exploring Earth Science: Geology* (Chapter 3).
3. Collect and identify some of the organisms found in topsoil.	Collect soil organisms (other than microorganisms) and examine them in the laboratory.	*Exploring Earth Science: Geology* (Chapter 3).
4. Distinguish between weathering and erosion. 5. Give examples of physical and chemical weathering. 6. Cite examples of erosion by water and wind.	Examine on site or from photographs, examples of physical and chemical weathering and of erosion. The student can provide many examples for class analysis.	*Exploring Earth Science: The Earth's Surface* (Chapter 2).
7. Define a mineral.	Examine a variety of minerals for hardness, streak, cleavage, fracture, colour, flame test colour, the effect of heat, lustre.	*Exploring Earth Science: Geology* (Chapter 1).
8. Describe and use some tests for identifying minerals.	Test for some of the above characteristics.	*Exploring Earth Science: Geology* (Chapter 1).

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Objectives	Activities	Materials
9. Acknowledge the economic and aesthetic values associated with soil, weathering, and erosion.	Projects, speakers, and class discussion.	*Exploring Earth Science: Geology* or *MAPS: Soil, Sea, and Sky*

Extensions

1. Describe the role of the wind in building up the earth's surface.	Investigate the effects of wind on various types of soil, sand, and gravel.	*Focus on Science: Erosion* (Chapter 2) or Lab Inquiry Text: *Changes in the Earth's Crust.*
2. Describe the role of the wind in forming sand dunes and loess deposits.	(a) Explain the action of a migrating dune. (b) Read about the cave homes that are carved out of the loess cliffs in Northern China.	*Exploring Earth Science: The Earth's Surface* (Chapter 2).
3. Explain how rivers develop new land formations.	Investigate the carrying power of water and the process of depositing sediment.	*Searching for Structure: Rocks, Minerals and Fossils.*
4. Conduct an experiment to determine the properties in soil necessary for effective growth of plants.	Research and/or do projects on chemicals in the soil necessary for growing crops. Soil fertilization and soil analysis by agriculture representatives could be discussed.	Local district agricultural representative.

SPACE SCIENCE — INTRODUCTION TO SPACE SCIENCE

Rationale: Space science is introduced in grade 7 through the use of star charts and observation instruments. Many of the observations could be done by individuals or groups who would report to the class. Several skills are developed and processes used, although only limited fundamental space science concepts are presented. Numerous extensions are suggested, many of which are related to core objectives.

Objectives	Activities	Materials
The student should be able to:		
1. Use an astrolabe or other instrument to determine the position of selected celestial objects. Students can then plot the movements of these objects at different times during the year, evening, month, or week.	(a) Use the clock-angle method of locating objects (12 o'clock is north, 3 o'clock is east, etc.; the angle is the estimated angle above the horizon). (b) Use the astrolabe to determine the position of various objects according to their azimuth and altitude (the construction of the astrolabe is described in Extension 1). (c) Measure the position of *one* object at intervals throughout one evening. Note the apparent change of position.	(a) *Examining Your Environment: Astronomy* (Chapter 1). Further reference to this title will be *EYE-A*.
2. Use a star finder chart or other sky map.	Identify common stars, planets and constellations by referring to a star chart. Advanced students may attempt to sketch prominent stars and planets.	*EYE-A* (Chapter 2). Sky maps from local papers. Philip's Planisphere (plastic) Student Planispheres (cardboard) SC I Constellation Charts — good for a bulletin board display. The Planisphere, starcharts, and other teacher aids are available from the Manitoba Museum of Man and Nature gift shop, 190 Rupert Avenue at Main Street, Winnipeg, Manitoba, R3B 0N2 (204-956-2830).
3. Determine the sun's position throughout one day and/or determine the sun's position at the same time each day for a month.	Use the astrolabe to determine the sun's position. Stress the importance of *indirect* observations of the sun. If students have sufficient skill, graph the data. Introduce the students to the idea of earth movement.	*EYE-A* (Chapter 3) For an alternative method, see Appendix B, "Observing the Sun".

Objectives	Activities	Materials
4. Illustrate the motions of the moon and earth around the sun during a period of several months.	Construct a large diagram to illustrate the relative motions of the earth and moon. Students will require assistance with the scale used. Observe the moon daily. Record data. Generalize. Use the diagram produced to show the moon's phases.	*EYE-A* (Chapter 4). *EYE-A* (Chapter 3).
5. Construct a model of the solar system illustrating sun, planets, moons, and asteroids.	Collect necessary data. Diagram or make a model of the solar system. The emphasis should be on the objects and their relative positions rather than on an accurate scale of either size or distance.	*EYE-A* (Chapter 5). Library reference. Film: "NASA Universe".
6. Be aware of the unique position of space science among the sciences.	Discuss the difficulty of observations in space science compared to other sciences. Compare the observational approach of space science with the experimental approach that is possible with some other science areas.	None.

Extensions

1. Construct an astrolabe.	The astrolabe consists of a full circle protractor for measuring azimuth, and a half circle protractor topped by a sighting straw to measure altitude.	*EYE-A* (Chapter 1).
2. Complete some or all of the projects in "The Earth in Space" module.	Problems 7-1, 7-2, 7-4. Reference Laboratory Inquiry sheet 7-2 and worksheet 7-2 relate to core objectives 1. Reference sheet 7-3 and Problem 7-5 relate to core objective 2.	Lab Inquiry Text: *Earth Science; The Earth in Space,* (module).
3. Find a coloured (red or orange) star. Identify and/or plot its position.	Locate a red or orange star. Identify using a sky map and/or determine its position using an astrolabe.	None.
4. Photograph stars or star trails.	Experiment with photographic techniques. Assemble a display.	*EYE-A* (Chapter 2).

Objectives	Activities	Materials
Extensions (cont'd)		
5. Determine the number of visible stars in the sky.	Devise a method of "counting" stars. Report to the class.	*Exploring Earth Science: Astronomy* (Chapter 4) or *Exploring Science*: Stage 1, "Watching the Sky".
6. Find out when a meteor shower will occur and observe it.	Refer to a table showing the occurrence of meteor showers for suitable viewing times. Observe and record the constellations in which the meteors occurred.	*EYE-A* (Chapter 5). Observers' Handbook (current year).
7. Observe and describe sunspots.	Experiment with methods of observing sunspots. Report. Any toy telescope of 20 or 30 power is sufficient to show sunspots. CAUTION: USE INDIRECT OBSERVATIONS.	*EYE-A* (Chapter 3). See Apperdix B, "Observing the Sun".
8. Construct a telescope.	Construct a telescope from a kit or other materials. Contact Planetarium staff for useful information. This could be integrated with the Physics Unit.	*EYE-A* (Chapter 4). The advertisements in "Sky and Telescope" magazine are the marketplace for telescopes and telescope making supplies.
9. Use a telescope or binoculars.	Use a telescope or binoculars to observe the sky. Binoculars with 7 power (e.g., 7 x 35) will show the craters on the moon. Binoculars must be held steady or braced against a post.	See Appendix B, "Binocular Astronomy".
10. Report on the surface features of the moon that are visible with a telescope or binoculars.	Observe the moon's surface with a telescope or binoculars.	*EYE-A* (Chapter 4). See Appendix B, "Binocular Astronomy".
11. Distinguish between astronomy which is a science and astrology which is a pseudo-science.	Discuss the differences between astronomy and astrology.	*EYE-A* (Chapter 2).
12. Select and investigate further questions of interest.	Investigate questions of interest from "Branching Out" and "Digging Deeper" activities found within *EYE-A*.	*EYE-A*.
13. Report on a planetarium visit.	Arrange with a planetarium for a show suitable to topics being studied.	None.

PHYSICS — INTRODUCTION TO PHYSICS

Rationale: In grade 7 physics the student is introduced to the process of measurement. The process is then practiced through a number of data collection and interpretation activities using SI terminology. The geometry of light is studied and the data which is collected as the study progresses, serves as a basis for practicing measurement skills.

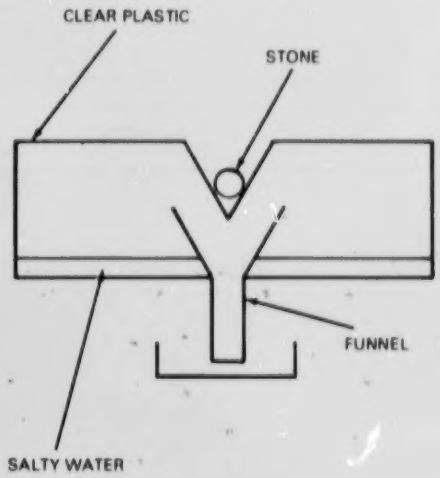
Objectives	Activities	Materials
The student should be able to:		
1. Collect, classify, and interpret data in accordance with the scientific method.	Discuss the process of observation as it applies to the scientific method; students will perform a number of skill building activities.	NOTE: The Cambridge text uses both SI and English units: teachers must consider this fact. *Cambridge Lab Inquiry Text: Methods of Science*.
2. Perform measurement in length, area, volume, mass, and time using SI terminology. Note: This objective may be a review for some students.	Laboratory problems requiring measurements of length, volume, and mass. By performing numerous measurement tasks, the students will develop their ability to achieve accurate results. Through repetition, the skill is reinforced. Note: Limitations of all measurement must be considered.	*Cambridge Lab Inquiry Text: Measurement* Problems 2-2 length, 2-3 volume, 2-4 relative weight, 2-5 mass (include reference sheets and work sheets).
3. Explain and cite practical examples of reflection and refraction of light from plane surfaces.	Laboratory problems requiring activity on the behaviour of light. (a) Trace the path of light through a smoke filled box. (b) Use a plane mirror for determining the principles of reflection. (c) Use a glass plate to determine how light refracts.	*Cambridge Lab Inquiry Text: Behaviour of Light*. 8-1 path of light, 8-2 construct light box, 8-3 visible path of light ray, 8-4 incident and reflected rays, 8-5 mirror images, 8-6 how light refracts, 8-7 path of refracted ray (Note: 8-7 may be performed with liquid filled container as well as glass). Include reference sheets and work sheets.
Extensions		
1. Calibrate a balance to increase its precision.	Laboratory activity involving simple pan balance.	*Cambridge Lab Inquiry Text: Measurement* (Problems 2-6 and 2-7).

Objectives	Activities	Materials
Extensions (cont'd)		
2. Measure the temperature of water.	Laboratory activity involving change of state.	*Cambridge Lab Inquiry Text: Measurement* (Problem 2-8).
3. Measure the magnifying power of a convex lens.	Laboratory activity using an optical instrument for magnification.	*Cambridge Lab Inquiry Text: Behaviour of Light* (Problem 8-8).
4. Explain how light refracts through the lens of the human eye.	Make drawings of the eye with the light rays refracting to the retina. Do the same for lenses which correct eye defects.	*MAPS: The Physical World.*

CHEMISTRY — INVESTIGATING STATES OF MATTER

Rationale: By observing the fundamental properties of different states of matter, the grade 7 student learns about the nature of physical change. By observing changes of state, classifying matter, and measuring such factors as boiling point and freezing point, the student will develop basic process skills. The investigative approach taken in the study of these topics will help develop the student's ability to manipulate common laboratory apparatus.

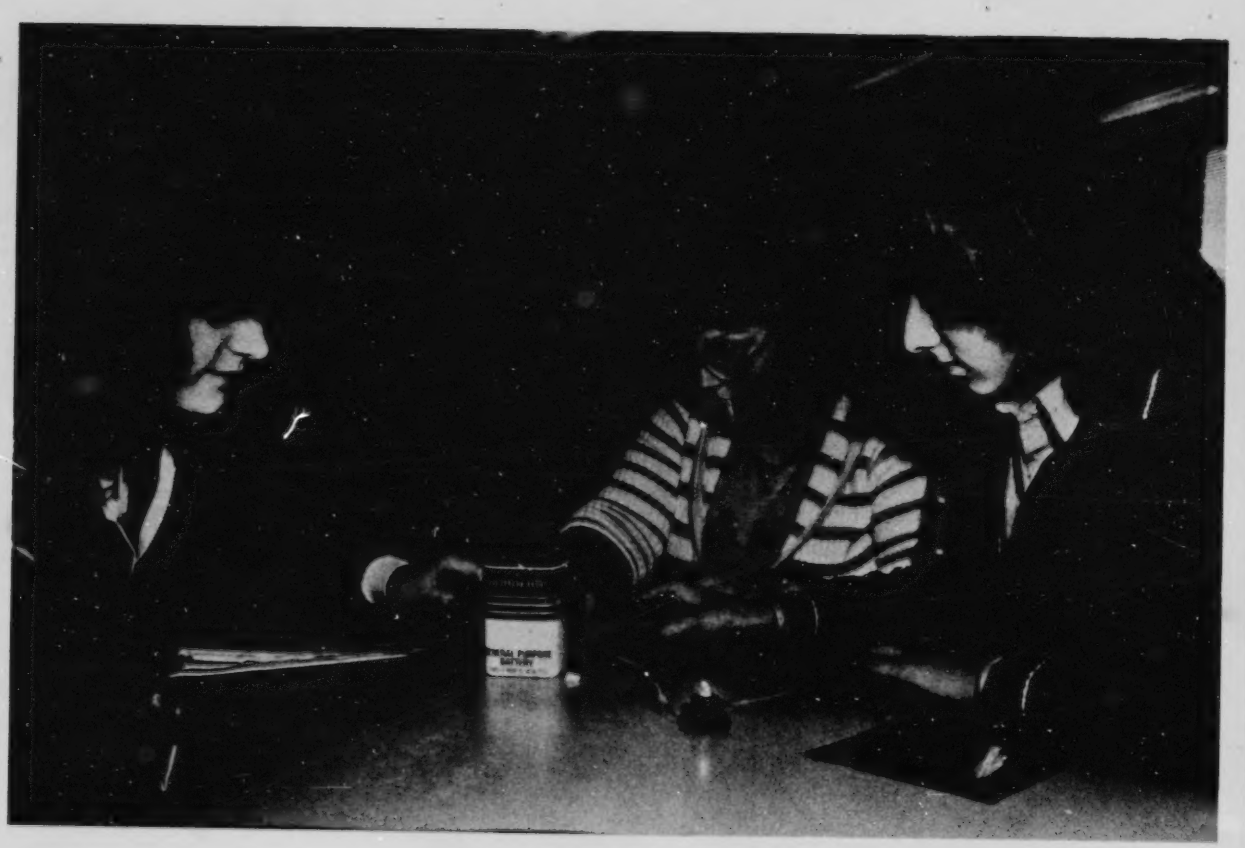
Objectives	Activities	Materials
The student should be able to:		
1. Classify given materials in terms of the three states of matter.	Observe examples of the different states of matter and describe similarities and differences between them. Classify substances in terms of states of matter, using actual substances and/or pictures.	*Searching for Structure: Solids, Liquids, and Gases* (Changes of State) or *ASEP: Water*.
2. Name and define the processes, in terms of heat requirements, by which matter changes from one state to another: evaporation, boiling, condensation, melting, freezing.		*Searching for Structure: Solids, Liquids and Gases* (Changes of State) or *ASEP: Water*.
3. Compare the rate of evaporation of water at different temperatures.	Use beakers filled with equivalent volumes of water and place into areas where temperature differences occur. Use a heat source if desired. Check temperature and water levels regularly. Chart results and compare.	*Searching for Structure: Solids, Liquids, and Gases* (A Familiar Liquid: Water) or *ASEP: Water* (Core and Option 3).
4. Compare the rates of evaporation of different liquids.	Use liquids such as cooking oil, methyl alcohol, water and glycerine. Place drops on hand.	*Physical Science: Chemistry* (Matter and its States) or *Exploring Science:* Stage 1 (Water as a Chemical).
5. Describe a test for water.	Use anhydrous copper sulfate or cobalt II chloride paper.	No reference.
6. Describe the effect of cooling on water vapour (condensation).	Use beakers, ice cubes and water. Test the condensation on the side of the beaker.	

Objectives	Activities	Materials
7. Graph the temperature change that occurs and the time required when melting ice and when freezing water.	Break ice cubes into small pieces, place into a beaker of water, and record temperature changes at regular intervals until no temperature change occurs. Predict the temperature change after ice melts. Repeat for freezing water.	*Searching for Structure: Solids, Liquids, and Gases* (Changes of State) or *ASEP: Water* (Option 3).
8. Graph the temperature change and measure the time requirements when heating water to boiling and boiling the water for a period of time.	Heat cold water until it has boiled for 5 minutes. Record temperature changes at regular intervals and graph. A graph of the results of this experiment can be provided to students for interpretation.	*ASEP: Water* (Option 3).
9. Relate changes of state to the water cycle and develop an awareness of the importance of the water cycle.	Design a poster which illustrates the water cycle in nature; discuss the changes of state involved; discuss the importance of water to life. Discuss the movement of underground water, waste disposal, and make a model well using fine gravel, a beaker, and water. Discuss methods of obtaining water from the air in desert conditions. Make a solar still using a frame, clear plastic, and a funnel. Examine plants for transpiration by covering the leaves with a plastic bag and testing the liquid which is caught with anhydrous copper sulfate or cobalt II chloride paper.	*Searching for Structure: Solids, Liquids and Gases* (A Familiar Liquid: Water) or *ASEP: Water* (Core). 

Objectives	Activities	Materials
Extensions		
1. Describe the volume changes of water and other liquids upon freezing.	Freeze samples of water and wax and determine the volume changes; discuss the importance of the changes for water. Half fill a test tube with water; freeze. Measure the original and final volumes (lengths) of water in the two states. Compare masses of equal volumes of ice and water. What are the implications for the floatation of ice? Compare the masses of equal sized cubes of wood, aluminum, polystyrene foam, and brass or similar materials to an equal volume of water. Use a bucket kit. Students can estimate and then measure the floatation qualities of the cubes.	*Searching for Structure: Solids, Liquids and Gases* (A Familiar Liquid: Water) or *ASEP: Water* (Option 4). Bucket kits can be made by glueing plastic rectangles or tin plates together.
2. Describe how low and high air pressures affect the boiling point of water.	Use the technique of "low pressure by condensation" to boil water at less than its boiling point.	*Exploring Physical Science: Chemistry* (Changes of State). *Exploring Science: Stage 1* (Water as a Chemical).
3. Demonstrate experimentally the effect of the addition of substances on the freezing and boiling points of water.	Use a common solute such as sugar or salt to determine its effect upon the freezing point and boiling point of water.	*Searching for Structure: Solids, Liquids and Gases* (A Familiar Liquid: Water).
4. Describe "hardness" in water, its effects upon household uses of water, and methods of controlling it.	Test the effects of samples of distilled water, water and calcium bicarbonate, water and magnesium sulfate, and tap water with soap and detergents. Determine the effects of boiling and of sodium carbonate upon hardness. Experiment with the process of purification by distillation.	*Searching for Structure: Solids, Liquids and Gases* (A Familiar Liquid: Water).
5. Compare the effectiveness of filtration and distillation as methods of purifying water.	Perform filtration and distillation using solutions and suspensions of water.	*Life and Environment Series: Water World* (Water Use) or *Searching for Structure: Solids, Liquids and Gases* (A Familiar Liquid: Water).

Objectives	Activities	Materials
Extensions (cont'd)		
6. Be aware of the importance of water in our daily lives. (a) Be able to list and compare major household uses of water. (b) Be aware of methods of conserving water.	Determine the quantities of water required for different activities and compare the quantities within individual and class surveys. Examine methods of recycling and conserving water.	As above.
7. Research and write a report explaining the causes and possible remedies for water pollution problems.	Use library reports, local conservation authority reports, newspaper clippings.	C. Markell, *(Burlington Dam Debate An Environmental Education Simulation Game* (available from Department of Education Library — deals with the Souris River).

GRADE 8



ENVIRONMENTAL SCIENCE — MICROBIOLOGY

Rationale: The unseen world of microbes affects both the organic and the inorganic components of the environment. Micro-organisms are found in aquatic, soil and terrestrial ecosystems. As saprophytes they help recycle elements; as parasites they control plant and animal numbers. Without micro-organisms, soils would soon be depleted, and the growth of plants would cease. Refer to *Safety in Science for Manitoba Teachers* for precautions in handling microbes.

Objectives	Activities	Materials
The student should be able to:		
1. Describe the ways in which bacteria influence or modify our environment/lives.	(a) Discuss both the desirable and undesirable influences of bacteria. (b) Assign above as individual research project.	Library reference.
2. (a) Prepare a stained slide of bacterial culture. (b) Identify the bacteria as coccus, spirillus, or bacillus.	(a) Refer to laboratory activity "Microscope Observation of Bacteria" from teacher's general reference. (b) In conjunction with above lab, compare shapes of bacteria.	(a) and (b) *Focus on Life Science: Activity Centred Program; Teacher's Guide* (Unit 3 — Chapter 1: one copy is needed).
3. (a) Describe the nutrition requirements of bacteria. (b) Differentiate between a ciliate and a flagellate.	(a) and (b) Discuss different nutrition requirements among bacteria.	(a) and (b) *Focus on Science: Microbes and Disease*.
(c) Identify a protozoan under the microscope.	(c) Compare washed and unwashed hands in terms of bacterial growth in agar. Expose bouillon soup in test tubes to air. Control variables.	(c) *Focus on Life Science: Activity Centred Program; Teacher's Guide.* *Life Science: A Learning Strategy for the Laboratory* — Lab 26.
4. (a) Define and cite examples of a protozoan.	(a) Observe cultures of protozoans from hay infusion.	(a) *Focus on Life Science: Activity Centred Program; Teacher's Guide* (Unit 3, Chapter 2) — Preparation of a hay infusion.
(b) Differentiate between a ciliate and a flagellate.	(b) Use texts and photos of ciliates and flagellates to arrive at a list of differences and similarities.	(b) *Focus on Science: Microbes and Disease* (Unit 2, Chapters 3 and 4).
(c) Identify a protozoan under the microscope.	(c) Using a microscope, examine fresh pond water and pond water to which lettuce has been added.	(c) *Life Science: A Learning Strategy for the Laboratory* — Lab 28.

Objectives	Activities	Materials
5. Describe the process of fermentation.	Labs: (a) Compare the growth of yeast cells in two mediums, water, water and syrup. Compare the production of carbon dioxide in and the temperature of both mediums.	(a) *Life Science: A Learning Strategy for the Laboratory* — Lab 29. *Focus on Life Science: Activity Centred Program; Teacher's Guide.*
6. (a) Identify the characteristics of a mold, a yeast, a mushroom, a puffball.	(a) Assign research on types of fungi and their characteristics.	(a) *Focus on Life Science: Microbes and Disease* (3:2; Yeasts, 3:3; Molds, 3:5; Mushrooms).
(b) Compare and contrast the following pairs of organisms: i) a mold and a yeast; ii) a mushroom and a yeast; iii) a mushroom and a mold.	(b) Run a sequence of labs on each type of fungus. Molds i) Compare mold growth under different conditions (light, moist); ii) Grow mold cultures on various materials; Mushrooms iii) Obtain mushrooms and have students study the external anatomy. Have students make a spore print. Place the cap, gill side down and covered by a beaker, on pieces of both black and white paper. Caution; Check for allergies.	(b) *Life Science: A Learning Strategy for the Laboratory* — Lab 30. *Focus on Life Science: Activity Centred Program; Teacher's Guide.*
7. Determine the role of bacteria and of fungi as decomposers.	Discuss with class.	

Extensions

1. Analyze the effect of temperature on the respiration of a yeast cell.	Compare yeast cell respiration in both cold and warm baths, under room conditions. Use bromythymol blue to test for carbon dioxide.	*Focus on Life Science: Activity Centred Program; Teacher's Guide* (Unit 3, Chap-3) Yeast Cell Respiration and Temperature.
2. Determine the effects of various pollutants on plankton (yeast).	Test the effect of various chemicals upon yeast cells.	*Life Science: A Learning Strategy for the Laboratory* — Lab 56 — Plankton and Pollutants.

Objectives	Activities	Materials
Extensions (cont'd)		
3. Outline the changes that take place during succession within a micro-ecosystem.	Record the numbers and kinds of organisms in a hay infusion over a period of time.	*Focus on Life Science: Activity Centred Program; Teacher's Guide* (Unit 6, Chapter 2) — Succession on a Micro-level).
4. (a) Identify lichens as to shape: crustose, fruticose, foliose.	(a) Have students collect as many lichens as possible. Air dry and mount them. Use a handbook to identify them. Classify according to crustose, fruticose, foliose.	*Focus on Life Science: Activity Centred Program; Teacher's Guide* (Observation of Lichens).
(b) Discuss the importance of lichens for man and the environment.	(b) Assign as research project. Have students make a verbal or a written report.	(b) Library texts.
5. Describe the ways in which the animal body adapts itself to fight disease organisms.	Research and report on the body's defense mechanism against pathogens.	*Focus on Science: Microbes and Disease.*
6. Measure the growth of a microbial population.	Set up a culture of Daphnia (water fleas). Sample a pre-selected quantity at specific intervals, e.g., eye dropper full every 24 hours. Count number of daphnia to obtain an estimate of the population increase. Graph the results.	No reference.
7. Describe the factors that control the decomposition of a compost pile.	Students can set up compost heaps of uniform size and type. Vary such factors as moisture, aeration. Measure the temperature of the compost heap over a long period of time and graph results for each factor tested. *Use caution in the handling of any soil microorganisms. Hands must be protected.*	No reference.
8. Observe and describe the changes that take place over time (succession) to organic material.	Place slices of moist bread in a container and make qualitative observations over a period of several weeks.	*Exploring Life Science: The Environment.*

Objectives	Activities	Materials
Extensions (cont'd)		
9. Analyze a sewage treatment facility for the activity of bacteria.	(a) Students can visit a sewage treatment plant and report on the various bacterial processes required during the treatment of sewage.	
	(b) Written reports on sewage treatment can be assigned.	Library references.
	(c) Students can prepare a report on the functioning of a septic field.	Library references.
10. Design a series of experiments which would prevent foods from decomposing.	Prelab: Discuss the environmental needs of bacteria and how these environmental conditions can be altered.	Morholt, E., Brandewein, P.F. *A Sourcebook for the Biological Sciences.*
	Lab: Have students design, perform, and criticize an experiment that would illustrate an effective way of microbial growth prevention.	
	Possible themes (a) Dehydration.	
	(b) pH of specific substances, e.g., citric acid, vinegar.	
	(c) Salt concentrations.	
	(d) Spices.	
	(e) Temperature.	
11. Produce a food product from microbial activity.	(a) Students can make yogurt or cheese as a class project.	Library references. *ASEP: Microbes* (Teacher Edition).

LIFE SCIENCE — HUMAN ORGAN SYSTEMS

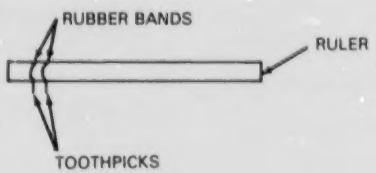
Rationale: Certain processes carried on by organisms are fundamental to the maintenance of life. In humans, these fundamental processes are maintained through properly functioning organ systems. The student is exposed to the basic organ systems through discussion and laboratory investigations. The intention of this unit is to develop an awareness and appreciation of life processes.

Objectives	Activities	Materials
The student should be able to:		
1. Define cells, tissues, organs, and organ systems.	Review terms. Remind the students that in grade 7 various animal organ systems are discussed, but in grade 8 emphasis will be on *human* organ systems.	*Focus on Science: Human Biology* (Section 1:1)
2. Define "diffusion" and explain its role in keeping a cell alive.	(a) Demonstrate diffusion by dropping a crystal of potassium permanganate in water in a petri dish. Project on a screen by means of an overhead projector. The molecules of potassium permanganate in water move from area of high concentration to areas of low concentration. Emphasize that the diffusion process occurs only when a substance dissolves in water.	(a) Potassium permanganate is found in most chemistry labs.
	(b) Do activity, *Dialysis Tubing and Corn Syrup.*	(b) *Focus on Science: Animals and Plants* (Section 2:6)
	Note: i. Omit osmosis. An attempt to differentiate osmosis from diffusion confuses students. ii. Emphasize that dialysis tubing represents a cell membrane; therefore, substances such as CO_2, oxygen, simple foods, H_20 and other wastes enter or leave a cell in solution from areas of high concentration to areas of low concentration. iii. Do not discuss Active Transport.	Refer to *Focus on Life Science: Activity Centred Program; Teacher's Guide* for lab procedure. *Focus on Science: Human Biology* (Section 1:1).
	(c) The following may be substituted for activity (b):	
	i. Fill plastic sandwich bag with a weak solution of ammonia.	
	ii. Insert plastic sandwich bag into a beaker containing a solution of water and phenolphthalein.	
	iii. The phenolphthalein turns pink because NH_3, passes through the plastic bag. Phenolphthalein, being a large molecule, does not enter the plastic bag.	

Objectives	Activities	Materials
	iv. Plastic bags are semipermeable.	
3. Discuss the structure and function of the heart, arteries, veins, capillaries and blood.	Discuss with the aid of charts. Refer to the cellular and tissue components of these parts. Point out to the student that these components make up the circulatory system. This section lends itself to lab work. An excellent source of organs is the local abattoir.	*Focus on Science: Human Biology* (Sections 2:1, 2:3, 2:5) *Focus on Life Science: Activity Centred Program; Teacher's Guide.* *Life Science: A Learning Strategy for the Laboratory* "Heart Sounds, Where are You".
4. Discuss blood circulation with reference to the heart, arteries, veins, and capillaries.	Discussion with reference to charts.	*Focus on Science: Human Biology* (Sections 2:4).
5. State the function of red blood cells, white corpuscles, platelets, lymph, and blood clotting.	Discussion. Deal briefly with these topics. Time is a factor if respiration and excretion are to be done and *related* to circulation.	*Focus on Science: Human Biology* (Sections 2:6, 2:7, 2:8).
6. Define respiration.	Compare oxidation with breathing (sugar + $0_2 \longrightarrow$ $CO_2 + H_2O$ + energy).	*Focus on Science: Human Biology* (Section 2:10).
7. Discuss the role of the diaphragm and ribs in breathing.	Discussion.	*Focus on Science: Human Biology* (Section 2:10).
8. Discuss carbon dioxide and oxygen pathways and exchange of gases in alveoli.	Discuss with reference to charts and diagrams. Emphasize the relationship of the blood circulatory system to that of respiratory system.	*Focus on Science: Human Biology* (Section 2:10).
9. Define excretion.	Blood carries wastes such as CO_2, H_2O, and urea from the cells. These wastes are removed by the lungs, kidneys and skin.	*Focus on Science: Human Biology* (Section 2:11).
10. Discuss the role of the kidneys and of the skin in excretion.	Discussion. Emphasize the role of circulation with respect to excretion. All body systems are interdependent.	*Focus on Science: Human Biology* (Section 2:11).

Objectives	Activities	Materials
Extensions		
1. Explain high blood pressure, heart attack, stroke, brain hemorrhage.	Discuss with the aid of diagrams.	Library research. *Focus on Science: Human Biology*.
2. Discuss the digestive system in humans: (a) Define digestion. (b) Role of mouth, stomach, small intestine, pancreas, liver, and large intestine. (c) Related diseases or illness such as ulcers, gall stones, appendicitis, diarrhea, and indigestion.	Lab: Test for the Presence of Starch and Sugar. Discussion. Observe the effect of equal volumes of the following on equal sized cubes of boiled egg white: water only; 5% pepsin solution; 0.2% hydrochloric acid solution; 5% pepsin and 2-3 drops of 0.2 hydrochloric acid. Discuss the results.	*Focus on Science: Human Biology* (Section 4:10). Refer to *Activity Centred Program: Teacher's Guide* for lab assistance. (Lab: Protein Digestion). (b) *Focus on Science: Human Biology* (Section 4:10).
3. Discuss the effect of tobacco, alcohol, and narcotics on the human body.	Discuss. Students may also research these topics.	*Focus on Science: Human Biology* (Sections 5:1 — 5:10).
4. Explain the general function of the central nervous system and the specific functions of the brain, nerve, and the spinal cord.	Discussion.	*Focus on Science — Human Biology* (Sections 3:1 — 3:5).
5. Discuss animal behaviours: (a) Inborn vs. acquired behaviour. (b) Reflex arc. (c) Training. (d) Instinctive behaviour. (e) Biological clocks.	5. (a) Discussion and research. (b) Discussion. Use simple demonstration and diagrams of reflex arc such as the knee jerk, blinking of the eye, and hand withdrawl from sharp or warm objects. (c) Discussion and research. (d) Discussion and research. (e) Discussion and research.	5. (a) — (e) *Focus on Science: Animals and Plants* (Section 3:1).

Objectives	Activities	Materials
Extensions (cont'd)		
6. Discuss diseases of the respiratory system.	Students can do research on the following diseases: (a) pneumonia; (b) T.B.; (c) bronchitis; (d) asthma (or allergy); (e) cancer; (f) sibicosis (miners disease).	Library reference.
*Extension Topic (*Consumer Science) This extension topic attempts to relate the broad concept of structure and function of the skin as part of an organ-system to the structure and function of clothing. The design of this extension attempts to develop concepts and the use of processes in the area of consumer science by comparing man-made and natural fibres. Objectives 1 and 2, which are concerned with the skin as an organ system, may be used to replace one of the core organ-systems, examined, or to relate the skin, the excretory and integumentary systems (skin-muscle).		
The student should be able to:		
1. Describe the basic structure of human skin:		
(a) Epidermis and dermis.	(a) Scrape the inside of the cheek and examine cheek cells.	*ASEP: Skin and clothes* A limited number of copies (5) will be required.
(b) Oil and sweat glands.	(b) Examine cross-section diagrams of the skin including epidermis, dermis, and fatty layer.	
(c) Hair, muscle, and pores.		

Objectives	Activities	Materials
Extension Topic (cont'd)		
2. Relate the basic structure of the skin to its functions:		
(a) As a protective layer.	(a) Test for oil on the skin by touching the forehead with thin paper. Place drops of water on the oiled part to test its effect. Test for oil on the finger by pressing a finger on a glass slide and dusting with powder. Discuss the role of the Malpighian layer as protection against sunlight and examine skin care.	*ASEP: Skin and Clothes* (Core).
(b) As a sensory surface map. Different areas of the skin vary in their sensitivity to touch.	(b) Make a sensitivity instrument. Toothpicks can be moved back and forth. Test the wrist for sensitivity by touching the wrist gently. Keep moving toothpicks together as long as you can feel them. This is a measure of sensitivity. Blindfold your partner and test the palm, tip of the thumb, calf of leg, side of face, etc. Test each area three times and work out the average for each area. 	*Examining Your Environment: Your Senses* (How do you Feel?) or *ASEP: Skin and Clothes* (Core).
(c) As a temperature regulating organ. Apply the knowledge of the skin as a temperature regulating organism to safety in the winter, e.g., cross-country skiing.	(c) Determine the position of pores on the finger by placing a 10% iodine solution on the tip of the finger, allowing to dry, and pressing the finger on a clean paper. Test the top of the hand for change in temperature by placing one or two drops of methyl alcohol on it. Check the effect of rate of evaporation by blowing on the top of the hand. Discuss heat control by the skin.	*Examining Your Environment: Your Senses* (How do you Feel?).
3. Relate the skin as an organ to the excretory and nervous systems.	Discuss the above activities relating the skin to the capillaries and sweat glands.	Discuss with physical education or local ski instructor. "Cross Country Skiing" and "Snow Camping" available from Curriculum Services, Department of Education.

Objectives	Activities	Materials
Extension Topic (cont'd)		
4. Compare the structure and function of various kinds of natural and man-made fabrics.		
(a) Identify the structures of different clothing materials and compare their qualities of temperature control and wind proofing.	(a) Identify fibres using a microscope. Test different fibres by wrapping them around cans of equal size and and shape. Place hot water into the cans, etc. Use a vacuum cleaner as a wind machine and test wind resistance.	*ASEP: Skin and Clothes* (Options 2-5).
(b) Test different fabrics for resistance to shrinkage, water absorption and drying time.	(b) Use wool, cotton, linen, silk, nylon, flax, jute. Use 50-100 cm lengths since shrinkage is small. Have students determine controls in the tests. Extensions: Discuss shrinkproofing and/or test waterproofing agents.	
(c) Test various fabrics for flammability.	(c) Have students design an activity to test flammability. Control variables of size, distance between the flame and the fabric, and the time when the fabric is set fire to.	*ASEP: Skin and Clothes* (Option 6). Caution: Use small quantities and vent the fumes.
5. Become aware of clothing habits of different cultures.	(a) Compare types of clothing worn by a variety of cultural groups. Discuss the functions of different kinds of clothing worn by different cultural groups. (b) Other possible extensions include examining the role of advertising and its effects upon buying habits, e.g., jeans. Compare ads in regard to the kind of information provided and how the ads attempt to influence buyers.	*ISIS: Buying and Selling* Useful as a teacher reference if the topic extends into advertising. Fibre comparison charts (check with home economics teachers).

EARTH SCIENCE — PATTERN'S IN THE EARTH'S CRUST

Rationale: In the grade 8 earth science program, students look at weathering and erosion in order to explain the formation of rock types, and to develop an awareness and an appreciation of the earth's resources. The theme of looking for and explaining patterns in our environment should be pursued. This program represents a more abstract study than that of grade 7 and, by its nature, demands greater expertise in both laboratory and cognitive skills.

Objectives	Activities	Materials
The student should be able to:		
1. Define and use the vocabulary associated with the terms *weathering* and *erosion* (talus, bedding, angle of rest, sediments, suspensions, oxbows, delta, alluvial fan, meandering stream).	Discussion on definition of weathering and erosion.	*Exploring Earth Science: The Earth's Surface* (Chapter 2 — Weathering) or *MAPS: Soil, Sea, and Sky* (Chapter 2).
2. Describe some of the physical and chemical processes by which rocks weather.	Direct observation, photo study, experimentation to examine the causes and effects of different weathering processes.	*Exploring Earth Science: The Earth's Surface* (Chapter 2 — Weathering) or *MAPS: Soil, Sea, and Sky* (Chapter 2).
3. Explain how weather and wind influence erosion.	Construct model of a stream to examine and experiment with variables such as the rate and volume of flow and the effect of slope upon water erosion. Observe and explain using the model or occurences in real life: delta, oxbow, alluvial fans, braided stream, meandering stream.	*Exploring Earth Science: The Earth's Surface* (Chapter 2 — Erosion by Streams) or *MAPS: Soil, Sea, and Sky* (Chapter 3).
4. Describe local examples of the effects and consequences of water and wind erosion.	Direct observation or photo study to examine wind erosion. Study and report on local examples of erosion.	*Exploring Earth Science: The Earth's Surface* (Chapter 2 — Wind Erosion) or *MAPS: Soil, Sea, and Sky* (Chapter 3).
5. Describe the formation and the characteristics of igneous, sedimentary and metamorphic rocks. 6. Identify and classify examples of the three main rock types.	Discuss, experiment, study and report on methods of rock formation (igneous, metamorphic, sedimentary). Examine and classify rock samples as igneous, metamorphic and sedimentary (sub-classify igneous into volcanic and plutonic).	*Exploring Earth Science: Geology* (Chapter 2 — The Nature of Rocks) or *MAPS: Soil, Sea, and Sky* (Chapter 5 — Rocks and Minerals).

Objectives	Activities	Materials
7. Explain the rock cycle.	Produce a diagram illustrating the cyclic nature of building up and wearing down of rocks.	*Exploring Earth Science: Geology* (Chapter 6 — Geologic Time) or *MAPS: Soil, Sea, and Sky* (Chapter 5 — Rocks and Minerals).

Extensions

1. State how sediments settle in water to form sedimentary rocks.	Conduct a series of rock forming experiments.	*Searching for Structure: Rocks, Minerals and Fossils*. Lab Inquiry Text: *Changes in the Earth's Crust*.
2. Describe how living organisms contribute to new land formations.	Examine types of coral and discuss how reefs are formed.	*Exploring Earth Science: The Earth's Surface*.
3. Describe the formation of mountains.	Research and discuss how a number of mountainous areas in the world were formed.	*Focus on Earth Science: Earth History* or *Exploring Earth Science: The Earth's Surface*.
4. Explain the nature of volcanoes and the causes of volcanic eruptions.	Study formation of volcanoes.	*Exploring Earth Science: The Earth's Surface* (Chapter 3) or *MAPS: Earth in Time and Space* (Chapter 4).
5. Describe the formation of fossils.	Study fossils and develop a geologic time scale.	*Exploring Earth Science: The Earth's Surface* (Chapter 4).
6. Be aware of the problems of erosion in an agricultural area.	Discuss wind erosion of soil, spring run-off, and methods of conservation.	Local examples. Information from Department of Agriculture representatives and pamphlets.

SPACE SCIENCE — EARTH, MOON AND SUN

Rationale: The grade 8 program begins by expanding topics introduced in grade 7. However, the emphasis in grade 8 is on processes and experimental evidence. Because of the difficulty of duplicating evidence by experiment of the characteristics of the earth, moon, and sun, research skills are important. Many of the suggested extensions could be correlated with core.

Objectives	Activities	Materials
The student should be able to:		
1. Describe the apparent motion of sky objects during the day and night sky.	(a) Plot the sun's position throughout one day. Use a method different from that used in grade 7 or treat as review. (b) Make several star observations at intervals one night. Record prominent stars on sky charts. This activity could be done as homework or by a small group as a project and reported to the class . Note the apparent movement.	*Exploring Earth Science: Astronomy* (Chapter 1) (Further reference to this title will be EES-A) Philip's Planisphere (plastic) Student Planispheres (cardboard) SC I Constellation Charts — good for a bulletin board display. The Planisphere, starcharts, and other teacher aids are available from the Manitoba Museum of Man and Nature gift shop, 190 Rupert Avenue at Main Street, Winnipeg, Man. R3B 0N2 (204-956-2830).
2. Describe and cite evidence of the motions of the earth.	Discuss, research, and use models.	*EES-A* (Chapter 2).
3. Describe experiments and other evidence used to determine the size and shape of the earth.	Discuss, research, and use models.	*EES-A* (Chapter 2).
4. Describe the shape, motions, and other characteristics of the moon.	Firsthand observations as described in grade 7 Space Science, extension 8. Research and discussion could substitute.	*EES-A* (Chapter 3).
5. Describe some of the moon flights and the information they produced.	Library research. Prepare a report.	Library references. NASA films: "On the Shoulders of Giants" and "Nothing So Hidden".

Objectives	Activities	Materials
6. Discuss the merits of space flights.	Research, discuss, and debate. Consider the future of space travel.	Library reference. G.K. O'Neill, "The High Frontier", Bantam Books, is a good teacher reference.
7. Describe some of the basic characteristics of the sun.	Firsthand observations of the sun, STRESSING PROTECTION OF THE EYES. Research.	*EES-A* (Chapter 3). See Appendix "B", "Observing the Sun".
8. Count for phases of the moon and for eclipses in terms of relative motion.	Use models, including students playing the parts of the sun, earth and moon.	*EES-A* (Chapter 3).
9. Be aware of the contributions of space scientists.	Research and describe the life, times, and contributions of one or more space scientists or astronomers.	Library references.
Extensions		
1. Explain sky observations as they might be explained by early people (sky motion) and as they are now explained (earth motion).	Discuss the extent of the knowledge of early people. Ask for reasons for today's explanation. Stress the necessity of additional evidence to decide on the correct explanation. Discuss other possible forms of evidence. (Correlate with Core objective 1).	*EES-A* (Chapter 1).
2. Describe differences in the night sky over several months.	Construct sky charts at monthly intervals or obtain such charts from local papers. Compare the positions of the same stars. Explain the differences.	Local papers.
3. Describe the differences in the night sky at different locations on the earth.	Obtain star charts from a distant location and compare to local charts. Account for the differences.	Star charts.
4. Describe the life cycle of stars.	Research. The life cycle of the stars can be related to our sun.	Library references.
5. Describe the apparent movement of a Foucault pendulum and explain how it shows evidence of earth's rotation.	Construct a model of a Foucault pendulum. Demonstrate and explain its motion.	*EES-A* (Chapter 2) or *Exploring Science: Stage 2*.

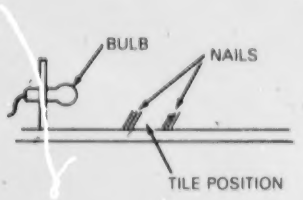
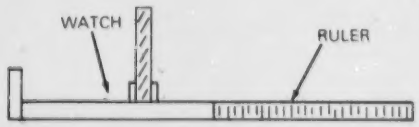
Objectives	Activities	Materials
Extensions (cont'd)		
6. Describe some aspects of rockets and rocket travel.	Research. Homemade rockets are generally *unsafe*. Federal Government approved motors and rocket kits purchased in hobby shops or at the MMMN should be used.	*Exploring Science: Stage 2* Refer to Appendix B for safety information for launching rockets.
7. Report on past, present, and future space exploration.	Research. Present a pictorial or written report. (This could be related to core objective 5).	Periodicals and library references.
8. Describe and account for some of the surface features of the moon.	Study the surface of the moon directly with the aid of a telescope, binoculars, or through photographs. Describe the possible formation of some of the surface features. (This could accompany core objective 4).	EYE-A (Chapter 4) See Appendix B "Binocular Astronomy".
9. Describe the use of the sun and stars in navigation.	Find your latitude by the north star using an astrolabe. Research other instruments and methods. Demonstrate to class.	Library references.
10. Describe and account for some of the following earth-moon-sun interactions: seasons, auroras, tides, solar radiation received on earth, effects on earth of solar disturbances.	Research. Use models. (This could be done in conjunction with core objective 8).	*EES-A* (Chapter 3).
11. Select and perform investigations from "Investigating on Your Own".	As suggested in each investigation.	*EES-A* (Chapter 4).
12. Report on a planetarium visit.	Arrange with a planetarium for a show related to topics being studied.	

PHYSICS — INVESTIGATING ENERGY

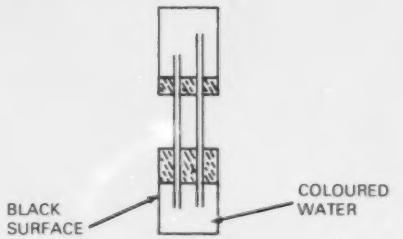
Rationale: In grade 8 physics, the topic of energy is used as a basis from which to investigate heat, electricity, and sound. The student begins by examining heat as a form of energy, and proceeds to apply the basic concepts of energy to the study of electricity. As a form of energy, sound is studied as part of the extension work.

Objectives	Activities	Materials
The student should be able to:		
1. Define energy by answering such questions as: (a) what is energy? (b) what forms does it exist in? (c) what is heat? (d) what is electricity?	Class discussion using current literature on energy. Use a model steam engine to convert heat to mechanical energy.	Current literature on energy, and *Searching for Structure: Heat and Electric Energy* (Unit 1).
2. Explain how mechanical, chemical, and electrical energy may be converted into heat.	(a) Produce heat by friction. (b) Produce heat by percussion. (c) Produce heat by compressing a gas. (d) Produce heat by dissolving substances. (e) Produce heat by electric current.	*Searching for Structure: Heat and Electric Energy* (Unit 1).
3. Determine the effects of heat energy on matter.	(a) Analyze the effects of heat upon the size of matter. (b) Study change of state due to heat. (c) Produce electrical energy with heat. (d) Determine the effects of heat on conductors (thermocouple). (e) Look for evidence of how heat breaks particles apart (e.g., decompose sugar, copper sulfate).	*Searching for Structure: Heat and Electric Energy* (Unit 2).

Objectives	Activities	Materials
4. Demonstrate and describe different ways of producing electricity.	(a) Convert chemical energy to electrical energy (wet cell, dry cell). (b) Convert mechanical energy to electrical energy (generator). (c) Convert light to electrical energy (photo-cell). (d) Convert heat to electricity (thermocouple).	*Searching for Structure: Heat and Electric Energy* (Unit 3).
5. Explain the effects of electric current on various solids and liquids (conductors, non-conductors).	Pass electric current through various materials (salt solutions, metals)	*Searching for Structure: Heat and Electric Energy* (Unit 4).
Extensions		
1. Describe how sound is generated, transmitted, and reflected in terms of its wave form and speed.	(a) Determine the origin of sounds. (b) Determine the effect of length of string and amplitude of vibration on the frequency and period of the pendulum. (c) Determine the effect of amplitude upon the frequency and period of the spring. (d) Examine the material needed for the transmission of sound. (e) Examine the properties of transverse and longitudinal waves.	*Searching for Structure: Light and Sound* (Unit 4).
2. Be aware of the problems associated with energy consumption in today's technological society.	Review current literature on the subjects of thermal pollution, transmission of electricity, insulation of buildings, alternative energy-conscious lifestyles.	Newspapers, magazines.

Objectives	Activities	Materials
Extensions (cont'd) **3.** Students have had an opportunity to examine heat energy and energy transformations. This knowledge can be extended into several areas: the application of knowledge about the transfer of heat energy to house construction and to energy conservation; the examination of the nature of solar energy as our primary source of energy; the transformation of energy; alternate methods of using solar energy.		
(a) Compare the rate of transfer of heat through different building materials.	(a) Build a material tester by using a light bulb in a socket set a fixed distance from a slot into which materials can be placed. Use equal area and thickness squares of different materials such as fibreglass, wood, ceiling tile. Build a thermometer holder so that it can be placed against the tile at the same spot for each test. Test the temperature change when the light bulb is on for one or two minutes at a time. Test the effect of thickness and air space. Test the effect of colour by using the same material painted different colours.	*ASEP: Places for People* A limited number of copies (5) may be useful. 
(b) Compare the sound conductivity of different building materials.	(b) Use the materials tester with a watch or other noise source on one side of the material and determine the distance at which sound fades (measure fading distance by placing your head near a ruler and moving it until the sound disappears).	
(c) Describe methods of conserving heat energy in the home.	(c) Discuss the most likely sources of heat loss in a home and the most effective ways of conserving heat energy. Compare major sources of heat loss in different styles of homes, i.e., bungalow, split level. Research the insulating qualities of a log house.	*100 Ways to Save Energy and Money in the Home*, Office of Energy Conservation, Energy, Mines and Resources Canada, 1975. *Keeping the Heat In*, Office of Energy Conservation, Energy, Mines and Resources Canada, 1976.
(d) Describe methods of decreasing sound transfer or reflection within a home.	(d) Suggest ways of baffling sound if one lives on a busy street. If most of the noise is transferred from one room to another through a door, describe ways in which the sound can be reduced.	Library references. Patrick A. O'Donnell and Charles Lavaroni, "Investigating Noise Pollution", Addison-Wesley Publishing Company Inc.
(e) Describe the transformation of sunlight to mechanical energy using a radiometer.	Observe the effect of sunlight upon a radiometer and discuss the transformation of the solar energy to mechanical energy.	*ASEP: Solar Energy* A limited number of reference copies may be useful.

Objectives	Activities	Materials
Extensions (cont'd)		
(f) Compare the effect of dark and light colours upon the transformation and absorption of solar energy.	(f) Use two thermometers and paint the bulb of one thermometer black. Test the effect of placing the thermometers in the shade, and in direct sunlight. Keep other factors constant. Record temperature changes over a period of 5-10 minutes.	
(g) Describe the composition of sunlight (spectrum).	(g) Use a prism or spectroscope. *Do not look directly at the sunlight.*	
(h) Compare the light absorptive qualities of common materials and describe colour in terms of the reflection of light.	(h) Using a spectroscope record the light spectra of common materials. Materials to be used could include white reflective and black paper, coloured materials, and green leaves. Discuss absorption and reflection of light in the atmosphere (bright days — about 70%-80% of solar energy reaches the ground; on cloudy days about 40%-50%).	*ASEP: Solar Energy* (Energy and Colour).
(i) Compare the absorption of radiant energy by various soils. Predict the absorptive quality of dark versus light soils. Suggest other factors affecting heating of earth's surface, e.g., nature of soil (sandy versus clay, size of particles).	(i) A thermometer may be placed into a vial of dark soil and placed a certain distance from a light source for a time period. Test a light soil — other soils.	*Examining Your Environment: Mini-climates* (Temperature in a mini-climate) or *ASEP: Solar Energy* (At the Earth's Surface).
(j) Construct a simple greenhouse and describe the greenhouse effect of the atmosphere.	(j) Use vial with a cap or one-hole stopper and a thermometer. The temperature changes of this thermometer can be compared to the temperature changes of an exposed thermometer when both are placed equidistant from a light source. Compare the greenhouse analogy to the atmosphere.	*ASEP: Solar Energy* (The Glasshouse Effect).

Objectives	Activities	Materials
Extensions (cont'd)		
(k) Construct a solar water heater.	(k) Construct a circulating-water type heater from a vial or test tube painted black, stoppers, and glass tubing. Test the temperature of the circulating water at intervals. *Caution: Provide safety instructions for cutting, glame treating glass, and methods of inserting glass into stoppers. It may be advisable for the teacher to provide students with the glass and stopper mechanism for assembly by the students.* Investigate the use of solar heaters in homes.	 *Alternatives* (available at Department of Education Library) or other magazine sources.
(l) Construct a solar reflector.	(l) A reflector may be made using aluminum foil and cardboard for support. Cardboard and reflector can be placed into different curvatures and tested by attempting to develop a reflector which will produce a bright line or spot on a sheet of paper.	*ASEP: Solar Energy* (Option 2 — Direct Use of Solar Energy).
(m) Compare the effects of heat upon a fixed quantity of water.	(m) One kilojoule will raise the temperature of 1000 g of water about 0.25° and a megajoule will raise the temperature of 1000 g of water about 25° C. Compare the daily average amount of solar radiation at Winnipeg to other parts of Canada and to Europe (7-14 megajoules/M^2) and other areas of the world. Research ways whereby solar energy can be used to heat homes (initially examine ways of controlling radiant energy gain and loss through windows).	*ASEP: Solar Energy* (Option 2 — Direct Use of Solar Energy).
(n) Compare rates of consumption among different countries.	(n) Comparisons are available in articles from *Scientific American* and *Energy in Canada*. Both sets of materials will have to be simplified, and graphs and information carefully chosen.	*Scientific American: Energy and Power*, 1971. C. LeMaistre, *Energy in Canada*, 1970. (available from Curriculum Services Branch, Department of Education). *The Car Mileage Book*, Office of Energy Conservation. Energy, Mines and Resources Canada, 1977.

CHEMISTRY — MATTER AND CHANGE

Rationale: Students will develop their ability to observe and identify patterns by studying physical and chemical changes. The causes, characteristics, and results of the changes, and the classification systems for some kinds of matter are investigated. The classification will be based on the results of examinations of the physical and chemical properties of some materials and on the observable results of the interaction of these materials with other substances. The search for patterns in the changes which occur will involve the continued use of simple and integrated processes.

Objectives	Activities	Materials
The student should be able to:		
1. Define the terms soluble, insoluble, suspension, dissolve, and solution.	Test the effectiveness of water as a solvent for various solids, liquids, and gases.	*Searching for Structure: Solids, Liquids, and Gases* (A Familiar Liquid — Water) or *AESP: Water* (Core).
2. Compare the solubilities of some substances in water.	Compare the solubility of solids such as sand, salt, copper sulfate, calcium carbonate, and sulfur. Students may wish to test the effect of fineness of powder upon dissolving rate.	*Searching for Structure: Solids, Liquids, and Gases* (A Familiar Liquid — Water).
3. Describe methods of separating dissolved and undissolved particles from a mixture or solution.	Separate the components of mixtures of sand and water, copper sulfate and water, or salt and water using filtration, heating or other techniques. Students should be able to make some suggestions for other techniques.	*Searching for Structure: Solids, Liquids, and Gases* (Changes of State).
4. Distinguish between a physical and chemical change, and describe the identifying characteristics of each.	Produce physical and chemical changes in the laboratory and discover the characteristics of each. Review changes of state of water (liquid, vapor, solid) and test for water using anhydrous copper sulfate or cobalt III chloride paper; review solid — liquid solutions (e.g., salt and water) and separation by evaporation (examine NaCl crystals before dissolving and after separation by evaporation).	*Searching for Structure: Solids, Liquids, and Gases* (A Familiar Gas — Air) and (Chemical Change).
5. Test for oxygen and carbon dioxide.	Use bromythymol blue or methylene blue (blue in presence of oxygen) to test for carbon dioxide and oxygen. Lime-water can also be used to test for carbon dioxide.	*Exploring Science: Stage 1* (Water as a Chemical) and (Oxygen and Oxidation) or *ASEP: Energy and Change* (Combustion).

Objectives	Activities	Materials
6. Describe and identify physical changes. In a physical change, one or more properties are changed but not the composition of the substance; energy may be released.	Refer to 4) above. Discuss other physical changes, other changes of state (wax, metals), production of small pieces (e.g., wood and rock chips), separation of suspensions, pounding of metals, growing of crystals.	*ASEP: Energy and Change*.
7. Observe and record some chemical changes on the basis of colour changes, weight changes and presence of new materials (products). Chemical change: change in properties and composition; some are reversible and some are difficult to reverse; most require more energy than a physical change.	Observe and record properties of a burning candle. Trap water vapour on the bottom of a beaker of cold water and test. Trap carbon dioxide and test with lime-water. Produce carbon dioxide using sodium bicarbonate and vinegar or alka seltzer and test gases produced. Chart the effects (colour changes) of heat upon basic copper carbonate, peanuts, wood, washing soda crystals, shiny copper sheet, copper sulfate crystals. *Use proper safety precautions in heating materials.* Burn magnesium ribbon and record changes. *Do not look* directly at the flame). You may wish to check to changes in mass. Demonstration: Production of oxygen for potassium chlorate and manganese dioxide. Test for oxygen. Electrolysis of water; recombine hydrogen and oxygen and test for water. (Demonstration) Investigate incomplete and complete burning using a bunsen burner by adjusting the air control, trapping soot on a beaker of cold water and the gases (water vapour, carbon dioxide) produced. Test for changes in exhaled air. Bubble ordinary air through bromythymal blue and blow into bromythymal blue through a straw.	*Science 5/13: Change: Stages 1, 2, and 3.* These two books are teacher support books *only*. *Searching for Structure: Solids, Liquids, and Gases* (A Familiar Gas — Air) and (Chemical Change). *ASEP: Energy and Change* (Option 4: Combustion).
8. Distinguish between endothermic and exothermic reactions.	Compare any of the above reactions. Compare the combustion of a match to heating zinc and powdered sulfur.	*Searching for Structure: Solids, Liquids, and Gases* (Chemical Change) Note: DO NOT use *mercuric oxide* with students. or *ASEP: Energy and Change* (Option 4 — Combustion) and (Option 5).
9. Identify physical and chemical changes that take place in the environment.	Observe the changes that take place in the laboratory and the outside environment and classify them as physical or chemical change.	

Objectives	Activities	Materials
10. Observe and state the general identifying characteristics of acids and bases.	*Warn students not to taste solutions and to use care in handling chemicals.* Test for acids and bases using an indicator such as litmus or phenol red. Test some natural indicators such as purple cabbage, juice or dyes made from deep red or deep blue flowers. Test the effect of acids on metals (Zn, Mg) and (polished Cu and Fe). Test the effect of dilute hydrochloric acid on marble and limestone, egg shells, sea shells and concrete chips). Use dilute solutions of hydrochloric acid, sodium hydroxide and phenolphthalein. Add phenolphthalein to a small quantity of base in a vial and alternately make the solution acidic and basic. Make inferences relative to the solutions. Predict pH values for the result of acid — base tests, e.g., greater or less than 7.	*Searching for Structure: Solids, Liquids, and Gases* (Chemical Change) or *ASEP: Pigments and Acidity*.
11. Classify acids and bases according to properties which have been determined through student investigation.	Classify common household items (vinegar, shampoo, baking soda, ammonia water, salt solution, lemon rind, apple juice) as acids or bases according to the results of independent student investigations.	
12. Manipulate laboratory equipment and chemicals to produce simple chemical changes and make basic chemical tests.	This objective is developed throughout the entire unit. Stress safety.	

Extensions

1. Investigate and record the effects of heat upon mass and colour of certain substances. Classify the nature of the change as physical or chemical.	Heat substances such as common salt, iron filings, copper carbonate, copper colin, tin or lead, wax, and washing soda crystals. Make students aware of safe procedures.	
2. Extract copper from copper II oxide.	Add powdered charcoal to half its volume of copper II oxide. Pour into test tube and cover with a layer of powdered charcoal. Heat until red hot and then cool on asbestos mat. Separate mixture by using water and skimming off charcoal.	*Science 5/13: Change* (Stage 3 — Making Use of Change and Energy).

Objectives	Activities	Materials
Extensions (cont'd)		
3. Discuss the effect of soil acidity upon plants.	Information is available from the Department of Agriculture. Tests for acidity can be conducted with pH paper.	*ASEP: Pigments and Acidity* (Soil Acidity).
4. Describe the effect of acids and saliva upon starch.	Use Benedict's solution as a test for sugar, then as an indicator to vials of: 1) starch solutions, 2) starch and HCl (dilute), 3) starch and Na (dilute) 4) starch and saliva. Warm solutions.	
5. Test the effect of pepsin upon protein.	Test the effect of pepsin and water, pepsin and acid, water and acid upon protein.	
6. Observe and describe the properties of crystals examined under a microscope.	Observe crystals under a microscope, e.g., salt, alum.	*Searching for Structure: The Structure of Matter* (Water, Crystals, and Solutions).
7. Discuss the procedure of and the difficulty in growing crystals.	Attempt to grow crystals, e.g., salt, alum, copper sulfate.	*Searching for Structure: The Structure of Matter* (Water, Crystals, and Solutions).
8. Apply the knowledge of crystal shapes to the building of models of simple crystals.	Construct physical models of salt or alum crystals, using styrofoam balls.	*Searching for Structure: The Structure of Matter* (Water, Crystals, and Solutions).
9. Describe the effect of temperature upon the rate of solution and amount of solute dissolved.	Dissolve potassium nitrate in about 200 ml of water and check for temperature changes. Saturate the solution, heat and predict the effect upon the capacity of the water to dissolve more solute. Saturate 50 ml of hot water with copper sulfate. cool rapidly.	

GRADE 9

ENVIRONMENTAL SCIENCE — LAND ECOLOGY

Rationale: Understanding the interaction within the ecosystem involves the study of food webs, energy flow, recycling of important materials, and the competition that occurs between living organisms. The interactions between plants and animals can be related to the interdependency of man and the ecosystem. Man's practices in maintaining natural areas are also examined. Field work is a necessary and important part of a land ecology program. Laboratory activities can lead to on-site investigations.

Objectives	Activities	Materials
The student should be able to:		
1. Differentiate between abiotic and biotic factors and discuss their interrelationship.	(a) Define terms and give examples.	(a) *Exploring Life Science: The Environment* (Studying an Ecosystem).
	(b) For a given list of ecosystems, have students outline the biotic and abiotic factors.	(b) No reference.
	(c) Bring in a rotten log and have students analyze its biotic and abiotic components.	(c) No reference.
	(d) Have students perform labs on measuring abiotic factors, e.g., light intensity, soil organic matter, relative humidity.	(d) Teacher reference: *Terrestial Ecology*, William A. Andrews — one copy recommended for teachers. *Focus on Life Science: Activity Centred Program; Teacher's Guide* (6-1).
2. Define and apply the following terms as they relate to organism relationships:		
(a) competition;	(a) Set up growth competition experiments with plants and discuss results with class.	*Exploring Life Science: The Environment* (Relationships Among Organisms).
(b) parasitism;	(b) Dissect an insect gall — willow or goldenrod. Study adaptations of leeches or tapeworms.	
(c) mutualism;	(c) Study ant — aphid relationship. Review lichen symbiosis.	
(d) commensalism;	(d) Cite examples of commensalism or prepare 35 mm slides to illustrate.	
(e) predation.	(e) Have students in small groups study predation in a community and its implications.	

Objectives	Activities	Materials
3. Differentiate between habitat and niche.	(a) Define habitat and niche, citing examples. (b) Select animals and plants from a particular ecosystem and have students qualify their niche and habitat.	*Exploring Life Science: The Environment.*
4. Define and use the terms producers, consumers, reducers/saprophytes, and scavengers, in relation to their role in the terrestial ecosystem.	Define and cite examples in different habitats.	*Exploring Life Science: The Environment.*
5. (a) Define energy.	(a) Review definition as developed in "Energy" module.	*Exploring Life Science. The Environment.*
(b) Describe ways in which organisms utilize energy.	(b) Confer with students in small groups or as a class on: (i) why organisms need energy; (ii) why *all* energy is not available to a consumer.	
(c) Discuss ways in which energy is lost.	(c) Confer with students in small groups or as a class on: (i) why organisms need energy; (ii) why *all* energy is not available to a consumer.	
(d) Define the term biomass.	(d) Define biomass and develop concept of pyramid of biomass (energy).	
6. Define succession and explain how it controls the development of a natural community.	Have students observe the changes that take place to an aquarium over time. Students can make qualitative observations as to biotic factors. Abiotic factors could be measured, e.g., pH, light, D.O.	*Exploring Life Science: The Environment* (Changes in Your Community).

Objectives	Activities	Materials
Extensions		
1. Conduct a population study within a natural land community and examine and estimate the interactions that occur within the population.	Quadrant sampling and transect sampling.	*Exploring Life Science: The Environment;* Terrestial Ecology, William A. Andrews — one copy recommended for teachers.
2. Investigate the interactions of the major cycles that sustain a land ecosystem (oxygen cycle, carbon cycle, nitrogen cycle).	Research and report on the major components of each cycle.	*Exploring Life Science: The Environment.*
3. Describe ways in which man's activity has altered or destroyed ecosystems.	Class debates on selected topics. Individual reports to class. Possible topics are: effects of pesticides on the environment; clear cutting, forest mismanagement: effect of forest fire control in National Parks; mercury pollution in our environment; effect of highway systems on wildlife; nuclear waste disposal.	*Exploring Life Science: The Environment.*
4. Determine the effect of pollutants on primary producers.	Test the effect of sulfur dioxide on plants by placing a plant into a plastic bag with a sulfur dioxide atmosphere.	*Life Science: A Learning Strategy for the Laboratory* (Lab 59).
5. Measure the effect of detergents on the germination of primary producers.	Test the germination rate of seeds in water and detergent.	*Life Science: A Learning Strategy for the Laboratory* (Lab 58).
6. Correlate climate (abiotic factor) to the quantity of growth of a tree (biotic factor).	Have the student secure: (a) a cross section of an old tree in which growth rings are visible; (b) climatic records for region where the tree was found. Student can measure growth increase in rings and relate to temperature and rainfall on a graph.	Climatic records are available from the weather office.

Objectives	Activities	Materials
Extensions (cont'd)		
7. Design and produce a visual essay on "Man's Effect on the Environment".	Have students in groups prepare a visual report on the state of our environment. Format can vary, i.e., 35 mm slide, 8 mm movie, colour prints, black and white prints. A script is mandatory. Topics could be specified, e.g., water pollution, urban environment.	*Improve Your Environment: Fight Pollution With Pictures* — Kodak publication which is available at most camera shops.
8. Discuss the sources of air and water pollution.	Assign a report (written or oral) on the different sources of air pollutants. Natural and man-made sources should be explored.	Library references.
9. Discuss the effects of pollutants on man and the environment.	Several essays could be assigned on the following topics: (a) Effects of water pollution on man; (b) Effects of water pollution on the biosphere; (c) Effects of air pollution on man; (d) Effects of air pollution on the biosphere.	Library references.
10. Perform a study on the impact of a manufactured item upon the environment.	Have students select a common item and have them outline all the natural resources required for its manufacture. Include all forms of energy required. Have the students specify the possible effects on the environment in the manufacture and disposal of this item. It would be best to design a flow chart for this activity on a large sheet of paper.	Library references.

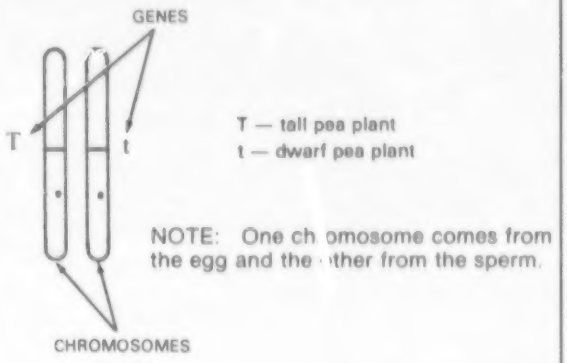
LIFE SCIENCE — REPRODUCTION AND HEREDITY

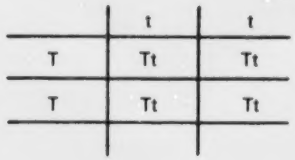
Rationale: The survival of any biological species depends upon the successful functioning of its reproductive system. The study of the reproductive system and of the principles of heredity is particularly apt for grade 9 students, who, at this time in their lives, are undergoing significant physical changes.

Objectives	Activities	Materials
The student should be able to:		
1. Through discussion, students should gain an understanding of the purpose of reproduction.	Discussion. A species must reproduce itself in order to survive.	No references.
2. Define asexual reproduction.	In asexual reproduction, an organism makes an identical copy of itself.	*Focus on Science: Reproduction and Heredity* (Section 1:2 — teacher reference). *Life Science*, 2nd edition (Idea 7 — Asexual Reproduction: teacher reference).
3. Name and describe briefly four kinds of asexual reproduction.	Four types of asexual reproduction are: budding, binary fission, mitosis and regeneration. Dry labs or labs using specimens or slides can be done to demonstrate these methods of reproduction.	*Life Science* (Idea 7 — Asexual Reproduction, Regeneration: teacher reference) or *Focus on Science: Reproduction and Heredity* (Reproduction in Animals — Sections 1:1 and 1:2).
4. Define sexual reproduction.	In sexual reproduction two parents are involved. The gamete from a male joins with a gamete from a female to form a new cell from which an offspring develops. The offspring has characteristics of both parents. Discuss.	*Life Science* (Idea 7 — Sexual Reproduction: teacher reference) or *Focus on Science: Reproduction and Heredity* (Section 1:3).
5. (a) Define sperm, egg, testis, ovary, gametes, fertilization, zygote. (b) Discuss sexual reproduction in single organisms such as paramecium or spirogyra. (c) Discuss sexual reproduction in complex multicellular organisms such as cat, dog, fish, or man.	(a) — (c) Discuss terms and processes with reference to Idea 7 "Sexual Reproduction". All questions should be answered by students.	*Life Science* (Idea 7 — Sexual Reproduction: teacher reference) or *Focus on Science: Reproduction and Heredity* (Sections 1:3, 1:4, 1:5).

Objectives	Activities	Materials
Note: Student and teacher have an option between core A or core B. This option is a necessity because time is a limiting factor. **A) Mammalian Reproduction** **B) Genetics**		
A. Mammalian Reproduction **The students should be able to:**		
1. Describe reproduction in a mammal.	Use charts and transparencies, if available, to illustrate the topics discussed.	*Focus on Science: Reproduction and Heredity* (Sections 1:5 — 1:7).
2. Describe the events in the estrus cycle.	Use charts and transparencies, if available, to illustrate the topics discussed.	*Focus on Science: Reproduction and Heredity* (Sections 1:5 — 1:7).
3. Describe the menstrual cycle in humans.	Use charts and transparencies, if available, to illustrate the topics discussed.	*Focus on Science: Reproduction and Heredity* (Sections 1:5 — 1:7).
4. Define: placenta, umbilical cord, gestation and fetus.	Use charts and transparencies, if available, to illustrate the topics discussed.	*Focus on Science: Reproduction and Heredity* (Sections 1:5 — 1:7).
5. Describe how mammals feed their new born.	Use charts and transparencies, if available, to illustrate the topics discussed.	*Focus on Science: Reproduction and Heredity* (Sections 1:5 — 1:7).
B. Genetics **The student should be able to:**		
1. Define the terms heredity and genetics.	Discussion.	*ASEP: Genetics* (Similar but Different) or *Life Science* (Idea 7 — Sexual Reproduction).
2. Identify variations in common characteristics of peas.	The teacher can make up a package of seeds including peas with variations in colour, size, and shape.	*Life Science* (Idea 7 — Sexual Reproduction: Sections A1-7) or *ASEP: Genetics* (Similar but Different).

Objectives	Activities	Materials
3. Identify variations in humans.	Match pictures of parents and their offspring. Which student belongs to which parent? If ASEP is not available, students can do class project by bringing their baby and parent pictures. Have class match pictures according to inherited similarities. Be aware of foster and adopted children in your class. Note: Do not discuss dominancy or recessiveness at this stage.	*ASEP: Genetics* (Similar but Different).
4. Identify chromosomes and genes and their role in inheritance.	Students must relate traits to genes that are located on the chromosomes. The lab using an onion root tip will clearly define the chromosomes. Genes are not visible on onion chromosomes but fruit fly chromosomes have visible genes. Note: Most schools possess a slide of an onion root tip. The "N" or normal cells are those whose nuclei are not dividing. On the same slide you can also find the nuclei which are undergoing division or mitosis. The chromosomes will be clearly visible.	*Life Science* (Idea 7 — Sexual Reproduction).
5. (a) Distinguish between a dominant and a recessive trait. (b) State the Law of Dominance.	Give students the following list of traits and have them determine which are dominant or recessive. Students can gather data for each trait within the class or a number of classes. The ratio between the number of dominant and recessive characteristics within each trait can be compared. The following list is for teacher reference: Dominant / Recessive tongue roller / non-roller hooked nose / straight nose brown hair / blonde hair non-blue / blue eyes freckles / no freckles fat figure / lean figure prominent teeth / normal teeth long eyelashes / short eyelashes round face / long face curly hair / wavy or straight hair protruding ears / ears lie flat thick lips / thin lips	*ASEP: Genetics* (Similar but Different). Note: Students may be bothered by relating some personal traits to heredity. Teachers should use care in the choice of traits to be examined or may prefer to use pictures to develop this concept.

Objectives	Activities	Materials
6. Identify dominant and recessive traits by means of symbols.	Genes for the same trait are represented by the same letter. The dominant gene is represented by a capital letter and recessive gene by lower case letters.  	No references.
7. (a) State and discuss the Gene Theory. (b) Discuss meiosis and fertilization and relate to the Gene Theory.	(a) — (b) For each trait there are basically two genes which control heredity. Genes occur in pairs. According to the Gene Theory a new organism obtains half its genes from the sperm and the other half from the egg. The processes of meiosis and fertilization make this possible. Discuss meiosis and fertilization. Do not discuss meiosis in detail.	*Focus on Science: Reproduction and Heredity* (Sections 3:5 — 3:6) or *ASEP: Genetics* (Similar but Different).
8. Describe the procedure for solving genetic problems.	Apply the following procedure to solving genetic problems: (a) KEY T — tall (dominant) t — dwarf (recessive) (b) Parental genotype TT x tt pure tall pure dwarf	*Focus on Science: Reproduction and Heredity* (Section 3:5) or *ASEP: Genetics* (Similar but Different).

Objectives	Activities	Materials
	(c) Reduction division or meiosis (d) Punnett square  F_1 (First filial generation) (e) Interpretation of Punnett square Genotype — ratio and % in F1: Answer — 100% Tt Phenotype — ratio and % in F1: Answer — 100% tall	
9. Solve genetic problems involving single dominant recessive traits.	Have students solve the following problems using the steps outline in activity 8. (a) Cross a pure black guinea pig with a pure white guinea pig (one generation cross). What is a hybrid? (b) Cross a black guinea pig with another black guinea pig. Both are hybrids (one generation cross). (c) Cross pure tall peas with pure dwarf peas. Students are to work out F_1 and F_2 generation. (d) Given phenotype and numbers of offspring, solve genotype of parents, e.g., black parents are mated resulting in the following offspring: 47 black guinea pigs; 16 white guinea pigs. Other crosses involving blending, sex determination, sex-linked traits are to be done as extensions only.	*Focus on Science: Reproduction and Heredity* (Section 3:3) or *ASEP: Genetics* (Options 1 and 2).

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Objectives	Activities	Materials
Extensions		
1. Describe the steps in the formation of a frog embryo.	Discussion using charts, models, direct observation (if done in the spring).	*Focus on Science: Reproduction and Heredity* (Section 1:8).
2. Distinguish between identical and fraternal twins.	Discussion.	*Focus on Science: Reproduction and Heredity* (Section 1:8) or *ASEP: Genetics* (Heredity or Environment).
3. Discuss pollination and fertilization in plants.	Discussion.	*Focus on Science: Reproduction and Heredity* (Sections 2:1 and 2:2).
4. (a) Discuss blending. (b) Solve problems involving blending.	Discuss and have students solve the following problems: (a) Cattle: pure white crossed with pure red; (b) Four o'clock flowers: pure white crossed with pure red; (c) Andalusian chicken: pure black crossed with pure white.	*Focus on Science: Reproduction and Heredity* (Section 3:4) or *ASEP: Genetics* (selective breeding).
5. (a) Discuss how sex is determined genetically. (b) Discuss and solve problems involving sex-linked traits.	(a) Discussion with reference to the Punnett square. (b) Discuss the following sex-linked traits. Have students solve problems of baldness, hemophilia, and colour blindness.	*Focus on Science: Reproduction and Heredity* (Sections 3:7 and 4:2) or *ASEP: Genetics* (Option 3).

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Objectives	Activities	Materials
Extensions (cont'd)		
6. Discuss relationships between heredity and environment.	Discuss the following traits and how environment may affect the expression of the genes: (a) Height, weight; (b) Intelligence; (c) The colour of potato sprouts in both the sunlight and in the dark.	*Focus on Science: Reproduction and Heredity* (Section 4:5) or *ASEP: Genetics* (Heredity or Environment).
7. Discuss the impact of genetic engineering on society.	Reference materials such as textbooks, the daily newspapers, and science magazines can be used in researching this topic.	Biology textbooks, newspapers, science magazines. *ASEP: Genetics* (Genetics and Disease, The Imperfect Copy, Inbreeding).

EARTH SCIENCE — WEATHER

Rationale: In the study of weather, introduced in grade 9 students are taught to construct and use instruments, to maintain records, to forecast weather conditions, and to explain the causes and nature of air mass interactions. Through these activities, the students develop skill in the use of the formal processes of inferring, hypothesizing, and predicting.

Objectives	Activities	Materials
The student should be able to:		
1. (a) Define and use the terms conduction, convection, radiation, saturation, land-breeze, sea-breeze, dew point, relative humidity, warm front, cold front, air mass. (b) Define, in operational terms, barometer, wet-and-dry bulb thermometer, hygrometer, and anemometer.	Prepare a model and do experiments to demonstrate heat transfer by conduction, convection, and radiation. Discuss land and sea breezes in relation to movements of the atmosphere. Water movement and primary atmospheric circulation may be researched and discussed. Note the effect of evaporation on cooling (methanol on skin). Use additional examples from the environment, especially to develop the concept of humidity, e.g., puddle evaporation on warm days is different from that on cold days. Use a wet/dry bulb thermometer, ensuring that the concept of saturation is developed. Maintain a record of relative humidity.	*Exploring Earth Science: The Atmosphere* (Gases in the Air) or *MAPS: Soil, Sea, and Sky* (Understanding the Weather, Explaining the Weather). Film: "The Angry Goddess", The Manitoba Telephone System.
2. Maintain an accurate weather record over a period of several months.	Examine other weather instruments and use them in maintaining a weather record.	
3. Describe the process of cloud formation and identify three major types of clouds.	Study, observe, and demonstrate cloud formation. Note the relationship of cloud types to weather forecasting.	*Exploring Earth Science: The Atmosphere* (Motions of the Atmosphere) or *MAPS: Soil, Sea, and Sky* (Understanding the Weather).
4. Describe what happens when a warm front meets a cold air mass, and when a cold front meets a warm air mass.	Discuss and classify air masses. Relate air temperature to density and buoyancy of air masses. Observe characteristics of air masses and interactions of air masses, e.g., frontal system. Consider pressure, temperature, precipitation, cloud type and wind velocity.	*Exploring Earth Science: The Atmosphere* (Motions of the Atmosphere) or *MAPS: Soil, Sea, and Sky* (Understanding the Weather).

Objectives	Activities	Materials
5. Forecast the weather, using SI units.	Report on weather proverbs and weather facts and fallacies. Take a trip to a weather office.	*Exploring Earth Science: The Atmosphere* (Motions of the Atmosphere) or *MAPS: Soil, Sea, and Sky* (Understanding the Weather).
6. Describe the effect of weather on lifestyle.	Investigate through discussion or projects how weather affects our choice of clothing, transportation, recreation.	*Lab Inquiry Text — Earth Science: Meteorology and Weather Prediction* or other references. Film: "The Angry Goddess", The Manitoba Telephone System.
Extensions		
1. Describe the role of satellites in weather prediction.	Library research.	
2. Describe the effect of volcanic eruptions on climate.	Library research, e.g., the effect of the eruption of Mount Krakatoa on the climate.	
3. Describe how radiant energy from the sun is transformed into heat energy. Note: Correlate with grade 8 energy unit.	Research and report.	*Exploring Earth Science: The Atmosphere* (Heating the Atmosphere).
4. Investigate the factors which affect the absorption by the earth of radiant energy. Note: Correlate with grade 8 energy unit.	Set up experiments which test the various factors affecting absorption.	*Exploring Earth Science: The Atmosphere* (Heating the Atmosphere).
5. Practice reading weather maps and develop one as a class project.	Study weather maps. Observe the trend of weather systems from day-to-day. Present a display of a series of weather maps.	*Exploring Earth Science: The Atmosphere* (Motions of the Atmosphere). Federal Weather Office maps, Environment Canada.
6. Illustrate methods of harnessing wind power.	Prepare a model and present a report on past uses of wind power and on present research.	

SPACE SCIENCE — THE UNIVERSE

Rationale: The grade 9 program is more abstract than Space Science in grades 7 and 8 and involves more formal thought processes. Theories are considered. Less readily observable objects in the universe are studied. Research is again a necessary skill because of the limited observations that are possible from a classroom. Several of the Extensions are designed to supplement specific core objectives.

Objectives	Activities	Materials
The student should be able to:		
1. Describe some of the characteristics of the objects in the solar system: sun, planets, moons, planetoids, comets, meteors.	Research and discussion.	*Exploring Earth Science: The Atmosphere* (Chapter 6). NASA Film: "Universe".
2. Construct a scale model of the solar system.	Collect data. Discuss scaling. Attempt to draw a model to scale with respect to both size and distances. Construct a model using a large open space. Alternatively, a cash register tape can be used, having a scale of 1 mm to 100 000 km.	*Exploring Earth Science: The Atmosphere* (Chapter 6).
3. Use or describe the use of the telescope, camera and spectroscope in investigating objects in space and describe the types of information each instrument gives.	Use as many of these instruments as are available. Describe the operation of each and the type of data collected. Compare the usefulness and limitations of each instrument.	*Exploring Earth Science: The Atmosphere* (Chapter 7). *EES-A* (Chapter 7). *Searching for Structure: A Universe to Explore* (Chapter 1) Teacher reference.
4. Describe some of the characteristics of galaxies (including the milky way), variable stars, novas and supernovas, binary stars, star clusters, nebulae, quasars, neutron stars, black holes.	Students can select topics for research and can do presentations individually or in a group.	*Exploring Earth Science: The Atmosphere* (Chapter 7).
5. Be aware of the fact that some of the problems encountered in studying the universe are due to the vast distances involved and/or to the movements of the earth and other space objects.	Refer to the speed of light when discussing the distances in space. In addition, also consider the fact that all objects are moving. Hypothesize the effects if the earth and/or other space objects did not move. The depth to which this topic is considered will vary.	

Objectives	Activities	Materials
6. Explain the statement "We are the stuff of stars".	The elements of which both the earth and ourselves are made, were generated in supernova explosions which occurred millions of years before the formation of our own sun. These explosions blew off gas clouds containing elements that condensed and solidified to form the solar system. From this information the students should be able to explain how these materials became part of our bodies. Thus, we are made of the stuff of stars.	Sagan, C and J. Agel. *The Cosmic Connection.* (This can be correlated with Conservation of Matter).

Extensions

1. Compare Ptolemy's and Copernicus' models of the universe.	Discuss the development, refinement, and use of scientific theories of the formation of the universe. Consider the evidence that led to the proposal of each theory. Discuss the explanations each could give to observations. Discuss the difficulties of applying each model to observations. State reasons for acceptance of the Copernicus model. Research the work, life, and times of one or both of the scientists.	*Exploring Earth Science: The Atmosphere* (Chapter 6). Library references.
2. Discuss the degree of acceptance of new discoveries in astronomy throughout history.	Research and discussion.	Library references.
3. Debate the theories of the origin of the universe (e.g., big bang, steady state, condensation theory).	Study debating procedures. Research and debate.	Library references. See especially *Astronomy* magazine.
4. Describe the solar system as it would be seen from some location other than earth.	Use a model to describe the sky from other locations such as the sun, the moon, Pluto, the Andromeda Galaxy.	
5. Explain the method of using parallax to measure distances in space.	Discuss how parallax can be used to measure the distance from the earth to some stars. Discuss the limitations of this method.	*Lab Inquiry Text: Earth Science* (The Earth in Space) — module (Problem 7-3 and Reference Sheet 7-1).

Objectives	Activities	Materials
Extensions (cont'd)		
6. Investigate the techniques of using spectroscope to study the materials of stars.	Use a diffraction grating and a simple spectroscope to study spectra given off by various materials (this may accompany core objective 3).	*Searching for Structure: A Universe to Explore* (Chapter 1)
7. Report on a planetarium visit.	Arrange for a planetarium show related to topics being studied.	
8. Become familiar with the use of *The Observer's Handbook*.	Study the information in the handbook. Use it to alert the class to the best times for observations. One student or group of students could be responsible for reporting to the class each month.	*The Observer's Handbook* (current year). *Searching for Structure: A Universe to Explore* (Chapter 1).
9. Investigate the measurement of position and time on the earth's surface.	Refer to activities listed in the references.	*Exploring Earth Science: The Atmosphere* (Chapter 5)
10. Discuss the scientific accuracy of a recent science fiction movie or television show.	Class discussion, debate and individual presentation or written report.	
11. Perform selected "Investigations" from Chapter 4 of the reference.	As outlined in each investigation.	*Exploring Earth Science: The Atmosphere* (Chapter 4)

PHYSICS — INVESTIGATING FORCE, WORK, MOTION, AND SIMPLE MACHINES

Rationale: The grade 9 physics student investigates force, work, and motion. Simple machines are considered in some detail. Motion is considered in terms of inertia and the principle of action/reaction. Acceleration is not dealt with.

Objectives	Activities	Materials
The student should be able to:		
1. Explain the relationship between force and motion expressing force in newtons and distance in metres.	Convert any measurements on the spring scales in grams to newtons and kilogram masses, mask over the original measurements with tape.	*Cambridge Lab Inquiry Text* (Force and Motion, Problems 5-1, 5-2).
2. Demonstrate the effects of the force of gravity.	Investigate the force of gravity using a spring scale.	*Cambridge Lab Inquiry Text* (Force and Motion, Problem 5-3).
3. Calculate the work done in lifting and moving objects.	Experimentally determine the amount of work done in lifting and moving objects.	*Cambridge Lab Inquiry Text* (Work, Energy and Simple Machines, Problem 6-1, reference 6-1, worksheet 6-1).
4. Illustrate the various types and classes of simple machines and determine the mechanical advantage of each. Note: Students should graph data whenever possible.	(a) Describe the way in which first and second class levers multiply force. (b) Describe the "Law of the Lever". (c) Graph the relationship between effort and resistance in second class levers. (d) Describe the way in which third class levers and inclined planes are used as machines. (e) Describe the way in which the slope of an inclined plane affects the amount of effort required to overcome resistance. (f) Determine the mechanical advantage of simple machines.	*Cambridge Lab Inquiry Text* (Work, Energy and Simple Machines, Problems 6-3, 6-4, 6-5, 6-6, reference 6-3, problems 6-7, 6-8, 6-9, reference 6-4, problem 6-1). Note: Rube Goldberg's devices as perpetual motion machines may be used for motivation.

Objectives	Activities	Materials
Extensions		
1. Explain the law of inertia.	Demonstrate Newton's first Law of Motion.	*Cambridge Lab Inquiry Text* (Force and Motion, Problem 5-4, reference 5-1, worksheet 5-1).
2. Discover the amount of frictional force between moving objects.	Discover the factors that affect the amount of frictional force between moving objects.	*Cambridge Lab Inquiry Text* (Force and Motion, Problem 5-5, reference 5-2, worksheet 5-2).
3. Explain the action — reaction principle.	Demonstrate the principle of action — reaction.	*Cambridge Lab Inquiry Text* (Force and Motion, Problem 5-6, reference 5-3).
4. Illustrate the effect of centripetal force.	Demonstrate the effect of centripetal force.	*Cambridge Lab Inquiry Text* (Force and Motion, Problem 5-7, reference 5-4, worksheet 5-3).
5. Explain the historical use of simple machines in: (i) building pyramids; (ii) weapons; (iii) application of machines in day-by-day activity.	Library references.	Library sources. *Science 5/13: Structure and Forces* (Stage 3). *Science 5/13: Science, Models, and Toys* (Stage 3). These are teacher references only.

CHEMISTRY — CHEMICAL INTERACTION

Rationale: In grade 9, the integrated processes of modelling and interpreting data are emphasized as the student seeks to analyze and explain the changes and interactions observed in grades 7 and 8. The atomic model of matter is used to explain the structure of matter and the nature of chemical interactions which occur in the student's environment. An introduction to chemical equations helps the student to describe the chemical reactions that he or she produces in the laboratory and to predict the occurrence of others. The student is introduced to the concept of chemical laws through a study of the Law of Conservation of Matter.

Objectives	Activities	Materials
The student should be able to:	Review the nature of chemical and physical changes, tests for carbon dioxide and oxygen, and solutions.	
1. Observe and state the general identifying characteristics of the following major classes of matter: (a) Mixtures (solid-solid) and solutions (solid-liquid); (b) Elements; (c) Compounds (compare elements and compounds to mixtures).	**(1) — (3)** Compare salt and iron fillings, sand and iron fillings, and a solution of water and copper sulfate or salt. Comparisons may be made by examining under a microscope. Separate mixtures into pure substances using filtration, distillation, or other means. Compare the products of distillation by testing for water. Compare the effectiveness of separation methods.	**(1) — (3)** *Searching for Structure: The Structure of Matter* (Classification of Matter) or *ASEP: Atoms* (What's the Matter).
2. Compare methods of separating mixtures.	Heat sugar in a beaker. Suspend a cold object within the beaker. Trap gases produced. Test the liquid (water) and examine the substance remaining in the beaker (carbon). Char the paper, sawdust, starch, bread in test tubes or by holding in a flame. Compare remains.	
3. Distinguish between synthesis and decomposition and classify some chemical reactions accordingly.	Decompose water by the method of electrolysis. Test for oxygen. Recombine hydrogen and test for water. (Demonstration.) Compare reactants and products and the ratios of the gases produced.	
	Produce copper from copper oxide and fire charcoal. Burn magnesium in air (do not view the flame directly). Examine the residue.	*ASEP: Atoms* (Hunting for an Element).

Objectives	Activities	Materials
4. Read about and discuss the statements of atomic theory and the model of the atom. Relate to some of the decomposition reactions such as the production of carbon or copper.	Identify the main statements of the modern atomic theory, and define basic terms associated with the atomic model of matter. Compare atoms and molecules.	*Seaching for Structure: Structure of Matter* (The Structure of Matter) or *ASEP: Atoms* (What's the Matter and Chemical Shorthand).
	Two or more nuts can be combined on a bolt to form a combination. The position of the nut on the bolt does not affect the molecule. Find out the possible number of combinations using two bolts and four nuts.	*ASEP: Atoms* (What's the Matter) *Searching for Structure: The Structure of Matter.*
5. Construct models of simple molecules using nuts and bolts or styrofoam balls.	Relate combinations to electrolysis of water (volumes of hydrogen to oxygen to produce model of water. Models of carbon monoxide and carbon dioxide (twice as much oxygen is needed to produce carbon dioxide as carbon monoxide). Note: The concept of modelling may be difficult for students.	*Searching for Structures: Structure of Matter* (The Structure of Matter) or *ASEP: Atoms* (What's the Matter and Chemical Shorthand).
6. Produce chemical reactions and describe them using simple chemical word equations.	Carry out basic chemical reactions in the laboratory, describing them with word equations or symbolic equations and molecular models e.g., preparation of hydrogen with zinc and sulphuric acid; preparation of oxygen from a weak solution of hydrogen peroxide; burning of magnesium, sulfur, copper, charcoal, or iron; decomposition of sugar. Hydrogen and oxygen experiments should be done using caution. (Demonstration).	*Searching for Structure: The Structure of Matter* (Changes). *ASEP: Atoms* (Chemical Shorthand).
7. Test for and state the Law of Conservation of Matter.	Combine solutions of silver nitrate and sodium chloride, or observe oxidation, or acid/base reactions. Compare reactions where all materials are trapped, to reactions where gases are produced and released. Explain the differences.	*Searching for Structure: The Structure of Matter* (Chemical Changes).

Objectives	Activities	Materials
Extensions		
1. Describe the terms "solution" and "precipitate" and explain dissolving in terms of separation of ions.	Combine lead nitrate and potassium iodide, separate out the precipitate, and examine the possible combinations of ions which produced the precipitate.	*ASEP: Atoms* (A Chemical Reaction).
2. Explain the conductivity of solutions on the basis on ions.	Test the conductivity of solutions. Discussion and reading about ions.	
3. Investigate methods of controlling fires and factors affecting combustion kindling temperature, spontaneous combustion).	Construct a simple carbon dioxide extinguisher. Caution: Use care concerning the quantities of reactants and pressure produced, and the strength of the container in order to avoid an explosion.	

APPENDIX
A

ANNOTATIONS

MODULAR MATERIALS

1. Heimler, Charles H. and David J Lockard. *Focus on Science.* Columbus: Charles E. Merrill, 1977. (paperback) Canadian representative: Charles E. Merrill Publishing Division, Agincourt, Ontario.

Life Science Modules

Animals and Plants 107 pp.
Microbes and Disease 75 pp.
Human Biology 108 pp.

Physical Science Modules

Properties of Matter 75 pp.
Changes in Matter 75 pp.
Measurement and Motion 107 pp.
Heat, Light and Sound 107 pp.

Earth Science Modules

Erosion 91 pp.
Earth's Matter and Origin 97 pp.
The Atmosphere and the Hydrosphere 107 pp.

This series of modules emphasizes content. Short activities are used to introduce or review the content developed within each section. Additional structured laboratory activities, available within *Life Science: A Learning Strategy for the Laboratory; Earth Science: A Learning Strategy for the Laboratory;* or *Physical Science: A Learning Strategy for the Laboratory,* may be useful for the appropriate science areas. The reading level for the life and earth science modules is generally appropriate for the average grades 7-9 student; the reading level in the physical science modules favours the average to above average student. Teachers' editions are available for each module. The modules are well illustrated and contain a glossary of difficult terms. Although the modules are primarily metric, some Imperial terminology is used. The *Activity Centred Program: Teacher's Guide,* available for life, earth or physical science provides additional laboratory activities and is *highly recommended as teacher support.*

2. Pike, Donald H (Ed.) *Searching for Structure Series.* Toronto: Holt, Rinehart and Winston of Canada Limited, 1973-75. (paperback)

Life Science

Microbiology 92 pp.
Ecology 92 pp.
Environmental Science 92 pp.

Earth Science

Rocks, Minerals and Fossils 124 pp.
Weather and Climate 92 pp.

Physical Science

Solids, Liquids and Gases 92 pp.
Structure of Matter 92 pp.
Heat and Electric Energy 76 pp.

This series of modules emphasizes both an activity-oriented approach to the topics as well as the development of concepts. Structured activities which state procedures and questions to be resolved are provided. Additional activities are suggested as extensions of specific investigations. Teachers may wish to eliminate some of the activities which suggest the use of special equipment. The reading level is appropriate for average or above average grades 7-9 students. SI units are used within the modules. Teacher guides, which provide information about basic equipment and teaching tips, are available.

3. Thurber, Walter A., Robert E. Kilburn, Peter S. Howell. *Exploring Life Science.* Boston: Allyn and Bacon, Inc., 1977. Canadian representative: Allyn and Bacon Inc., Toronto. (paperback)

The Environment 100 pp.
The Human Body 130 pp.

Exploring Earth Science

Geology 100 pp.
The Earth's Surface 130 pp.
The Atmosphere 100 pp.
Astronomy 100 pp.

Exploring Physical Science

Chemistry 97 pp.
Balanced and Unbalanced Forces 97 pp.
Heat, Sound and Light 89 pp.
Electricity 95 pp.
Energy 71 pp.

This series of modules incorporates a large number of demonstrations and laboratory activities, leading questions, and information in order to develop the concepts within each topic. The reading level generally is appropriate for grades 7-9 students. Teacher's guides are available for life science, earth science, and physical science.

4. Eisler, Sanford, M. et al. *Lab-Inquiry Texts: Physical Science.* New York: Cambridge Book Company, 1973. Canadian representative: Gage Educational Publishing Limited, Agincourt, Ontario. (paperback)

Measurement 30 pp.
Behaviour of Light and Sound 30 pp.
Methods of Science 30 pp.
Work, Energy and Simple Machines 30 pp.
Force and Motion 30 pp.

This series of modules incorporates numerous laboratories having well-defined procedures, questions, fill-in-the-blank sections, and tables. Limited numbers of copies of a unit are necessary. The units use both Imperial and SI units.

5. MacBean, J.C. et al. *Examining Your Environment: Astronomy.* Toronto: Holt, Rinehart and Winston of Canada Limited, 1976. (paperback, 96 pp.)

In addition to basic activities, several extension activities are included in the section entitled "Digging Deeper". The unit includes sections about the stars, the sun, the moon, and the planets. The book is well illustrated, though, the students may resent the abundance of photographs of younger children. The module has been converted to SI. A teacher's guide is available.

6. Cunningham, John D. et al. *Modular Activities Program in Science.* Boston: Houghton Mifflin Company, 1975. Canadian representative Houghton Miffin Company, Toronto, Ontario. (paperback)

Soil, Sea and Sky 168 pp.
Continuity of Life 112 pp.
Matter, Force and Motion 176 pp.
The Physical World 182 pp.

This series of modules incorporates activities which support the development of concepts and processes. Topics are divided into short sections; for example, erosion by water includes sections about the cutting action of rivers, the effect of plants on erosion, the sediment-carrying ability of a stream, deltas, and waterfalls. The reading level is appropriate for average and above average students. Information for teachers is available in a level seven teacher's guide for the modules *Matter, Force and Motion* and *Soil, Sea, and Sky*. The level eight teacher's guide contains information about the modules *Continuity of Life* and *The Physical World.*

7. *Australian Science Education Project*

Life Science

Genetics (Stages 2 and 3)
Skin and Clothes (Stage 2)

Physical Science

Water (Stage 1)
Energy and Change (Stage 1)
Pigments and Acidity (Stage 1)
Atoms (Stage 2)

The ASEP modular program uses structured activities and content to develop concepts. Specific directions and questions are used to

structure activities for the students. In addition, directions for activities are often supplemented with a sequence of pictures. The general design of each module employs a core option format: the basic concepts in core are related to concepts and activities within the options; the options often relate the science in core to applications. The developers of the program have attempted to relate core and each option to Piagetian stages of development (Note: The general stages of each module are specified). The reading level of the recommended modules is appropriate for most grades 7 and 8 students. The teacher modules specify stage and reading levels, objectives, basic equipment requirements, and approximate time requirements for each section. Teachers will be able to conduct classes using half a class set of ASEP materials. The modules recommended represent a less sophisticated approach to the study of chemistry.

8. Enever, Len (Project Director). *Science 5/13.* London: MacDonald Educational, 1973. Canadian representative: General Learning Corporation, Agincourt, Ontario.

   Change (Stages 1 and 2)
   Change (Stage 3)
   Structures and Forces (Stage 3)
   Science, Models and Toys (Stage 3)

   The modules in this series are intended to be used as teacher references. A series of activities which can be related to the general theme is presented. Time is required to organize the many ideas and to build and test simple equipment. The activities are designed to correlate with the general Piagetian stages of development, e.g., Stage 3 refers to the formal operational stage.

TEXTUAL MATERIAL

Textual materials are structured as life, earth, or physical science and will be used at more than one level within the junior high school program. Life, earth, and physical science texts are generally designed for the grade seven, eight, and nine levels respectively.

1. Heimler, Charles H. and David J. Lockard. *Focus on Life Science, Focus on Earth Science* and *Focus on Physical Science.*

   Refer to the previous description of modular materials within the *Focus on Science* series. Teacher's annotated editions are available for each of the books.

2. Wong, Harry K. et al. *Ideas and Investigations in Science: Life Science.* Englewood Cliffs: Prentice-Hall Inc., 1978. Canadian representative: Prentice-Hall of Canada Ltd., Toronto, Ontario.

   This book develops ideas such as photosynthesis and respiration, human systems, reproduction, and environmental relationships. A series of structured laboratory activities are used to develop concepts and processes. Diagrams supplement the written instructions for laboratory activities. The reading level is appropriate for average and below average students. Diagrams and photographs are used extensively to illustrate the written material. This book may also be useful with some slow learners. A teacher's manual is available.

3. Thurber, Walter A., Robert E. Kilburn, and Peter S. Howell. *Exploring Physical Science.* Boston: Allyn and Bacon, Inc., 1977. Canadian Representative: Allyn and Bacon, Inc., Toronto, Ontario.

   Refer to the previous description of modular materials within the *Exploring Physical Science* series. A teacher's guide is available.

4. Carter, Joseph L. et al. *Life Science: A Problem Solving Approach* and *Physical Science: A Problem Solving Approach.* Lexington: Ginn and Company, 1974. Canadian representative: Ginn and Company, Scarborough, Ontario (406 pp. and 439 pp.)

   Each topic within a text incorporates a number of short sections supported by activities which reinforce or extend the conceptual development. Specific laboratory procedures and questions are used to structure the activities. Teacher's editions are available.

5. Brown, Walter R. and Norman D. Anderson. *Earth Science: A Search for Understanding.* New York: J.B. Lippincott Company, 1973. Canadian representative: Lippincott Company, Toronto, Ontario. (703 pp.)

   The structure and history of the earth, water, air, and space are developed within this text. Some history of science and discussion of the economic importance of earth and water resources are also presented. The laboratory activities are generally short and support the development of concepts.

MATERIALS FOR EDUCATIONALLY DISADVANTAGED STUDENTS

1. Bernstein, Leonard et al. *Concepts and Challenges In Science: Books 1, 2 and 3.* New York: CEBCO. Division of Standard Publishing, 1977. Canadian representative: The Macmillan Company of Canada, Limited, Toronto, Ontario.

   These books provide students with easy-to-read science materials: the concepts appear on the left hand page and the activities, on the facing right hand page. Generally, every unit includes some simple activities, related information, a summary, questions, and extensions. The series is available in hard covered texts or soft covered modules. Each text contains topics from the life, earth and physical sciences. A teacher's guide, attached to the text, is available. The laboratory activities for each science in the text can be supplemented by the Laboratory Program for Concepts and Challenges in Science, e.g., the title *Laboratory Program: Concepts and Challenges in Science Physics Book 2* provides ditto masters for laboratory activities which will supplement the physics topics in book 2.

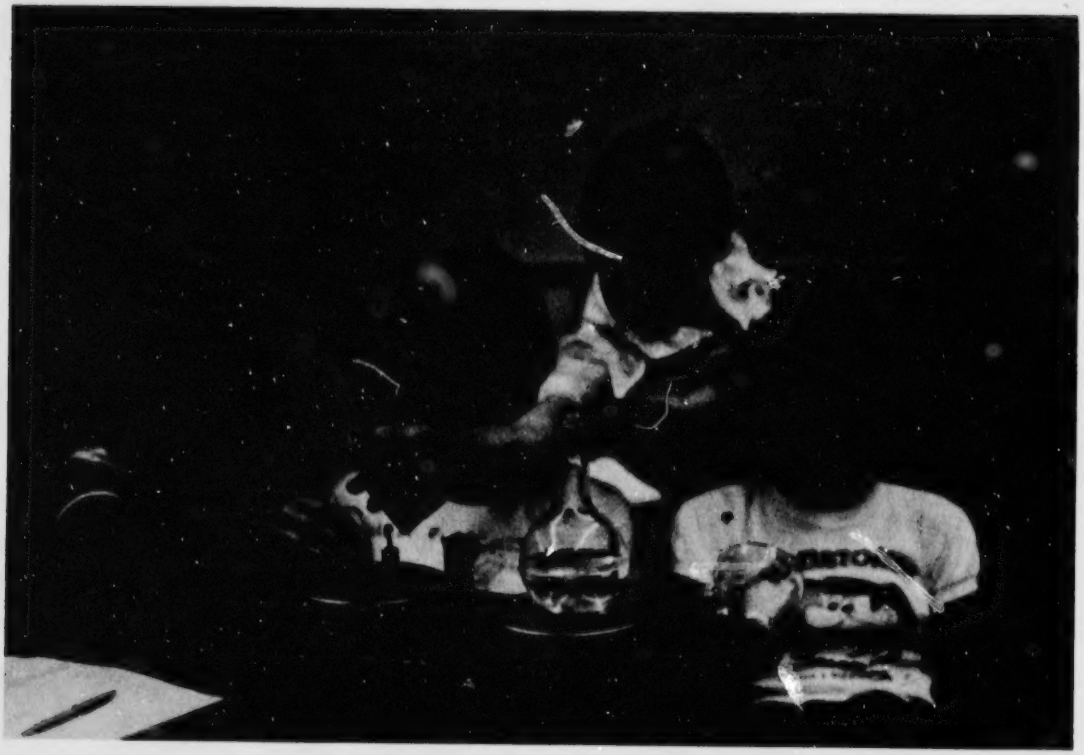
2. Oxenhorn, Joseph M. et al. *Pathways in Science.* New York: Globe Book Co. Inc., 1975. Canadian representative: Globe/Modern Curriculum Press, Markham, Ontario.

   The *Pathways in Science* series consists of 12 books written in simplified language covering units on biology, earth science, chemistry and physics. Each book is divided into a number of units and followed by a glossary; each chapter is divided into paragraphs that are numbered for easy reference. Illustrations are in full colour and accompanied by explanatory captions. Several student experiments and teacher demonstrations are also included in the texts. The materials have been written using SI units.

3. Hession, James F. D. Kemp, P. Grasse, and A. Chant. *Cambridge Work-A-Text: Science Is Experimenting* and *Science Is Predicting.* New York: Cambridge Book Company, 1977. Canadian representative: Gage Educational Publishing, Ltd., Agincourt, Ontario.

   These books are clearly and simply written. Interesting and very easy investigations called "Discover For Yourself" are provided to help students understand the ideas presented. Scientific terms and concepts are defined and developed so that the students will fully understand them. The materials contain both Imperial and SI units.

APPENDIX
B



Correlation Chart (Core Objectives)

Materials for Disadvantaged Students

Core Topics	LIFE SCIENCE	Core Topics	ENVIRONMENTAL SCIENCE	Core Topics	EARTH SCIENCE
Plants and Photo-synthesis	*Pathways in Science 1: Biology* Unit III, Chapters 1-7 *Pathways in Science 2: Biology* Unit II, Chapters 1-3 Unit III, Chapter 4 Unit V, Chapters 2-3 *Concepts and Challenges in Science: Book 1; Biology* Unit I, Sections 1-7 Unit II, Sections 14-21 *Cambridge Work-A-Text: Science is Experimenting* Unit I, Chapter 1 Unit II, Chapter 2 *Cambridge Work-A-Text: Science is Predicting* Unit I, Chapter 1 Unit II, Chapters 2-7	Biological Organization	*Pathways in Science 1: Biology* Unit III, Chapters 3-5 (See Life Science 7) Unit IV, Chapters 1-2 *Concepts and Challenges in Science: Book 1; Biology* Unit II, Sections 16-17 Unit III, Section 27 *Cambridge Work-A-Text: Science is Experimenting; Biology* Unit I, Chapter 4 *Cambridge Work-A-Text: Science is Predicting; Biology* Unit I, Chapter 3	The Earth	*Pathways in Science 1: Earth Science* Unit I, Chapters 6-7 *Concepts and Challenges in Science: Book 1; Earth Science* Unit I, Sections 4-8 Unit II, Sections 7-19 Laboratory Program *Concepts and Challenges in Science: Book 1; Earth Science* Sections 1-2 *Cambridge Work-A-Text: Science is Experimenting* Unit IV, Chapters 4-5

Correlation Chart (Core Objectives)

Materials for Disadvantaged Students

Core Topics	SPACE SCIENCE	Core Topics	PHYSICS	Core Topics	CHEMISTRY
Introduction to Space Science	*Pathways in Science 3: Earth Science* Unit I Unit II, Chapters 5-7, 9 *Concepts and Challenges in Science: Book 3; Earth Science* Unit II, Section 11 Unit III, Sections 16, 21 Unit IV, Sections 25-29 *Cambridge Work-A-Text: Science is Predicting* Unit IV, Chapter 5	Introduction to Physics	*Pathways in Science 3: Physics* Unit III, Chapters 11-16 *Concepts and Challenges in Science: Book 2* The Metric System, Selections 1-2 *Concepts and Challenges in Science: Book 3;* Unit II, Sections 16-23 *Cambridge Work-A-Text: Science is Experimenting* Methods of Science, Sections VII — X. Unit V, Chapter 5. *Cambridge Work-A-Text: Science is Predicting* Unit III, Chapter 3	Investigating States of Matter	*Pathways in Science 1: Chemistry* Unit I, Chapters 1-5 *Pathways in Science 2: Chemistry* Unit I, Chapters 1-2 Unit II, Chapters 1-6 *Concepts and Challenges in Science: Book 1; Chemistry* Unit I, Sections 1-7 *Laboratory Program Concepts and Challenges in Science: Chemistry, Book 1* Section 1 *Cambridge Work-A-Text: Science is Experimenting* Unit III, Chapter 3 Unit V, Chapter 1

GRADE 8

Correlation Chart (Core Objectives)

Materials for Disadvantaged Students

Core Topics	LIFE SCIENCE	Core Topics	ENVIRONMENTAL SCIENCE	Core Topics	EARTH SCIENCE
Microbiology	*Pathways in Science 2: Biology* Unit III, Chapters 1-7 *Concepts and Challenges in Science: Book 2: Biology* Unit II, Sections 11-20 *Cambridge Work-A-Text: Science is Experimenting* Unit II, Chapter 2 *Cambridge Work-A-Text: Science is Predicting* Unit II, Chapter 6 *Exploring Living Things* Unit V, Chapters 20-22	Human Organ Systems	*Pathways in Science 2: Biology* Unit IV, Chapters 1-5 *Exploring Living Things* Unit III, Chapters 10-11 *Life Science: A Problem Solving Approach* (Teacher Reference Only) Unit III, Chapters 8-10	Patterns in the Earth's Crust	*Pathways in Science 1: Earth Science* Unit I, Chapters 1-5, 8-11 Unit II, Chapters 4-9 Unit III, Chapters 1-6 *Concepts and Challenges in Science: Book 1: Earth Science* Unit I, Sections 9-16 Unit II, Sections 17-23 *Cambridge Work-A-Text: Science is Experimenting* Unit IV, Chapters 2 and 4 *Cambridge Work-A-Text: Science is Predicting* Unit IV, Chapter 2

Correlation Chart (Core Objectives)

Materials for Disadvantaged Students

Core Topics	SPACE SCIENCE	Core Topics	PHYSICS	Core Topics	CHEMISTRY
Earth, Moon and Sun	*Pathways in Science 3: Earth Science* Unit II, Chapters 7-9 Unit III, Chapters 10-14 Unit IV, Chapters 19-22 *Concepts and Challenges in Science: Book 3; Earth Science* Unit II, Sections 8-9, 12-14 Unit III, Sections 10-11, 19-20, 25-27 Unit IV, Sections 28-29 *Cambridge Work-a-Text: Science is Experimenting* Unit IV, Chapter 6 *Cambridge Work-a-Text: Science is Predicting* Unit IV, Chapter 6	Energy and its Relationship	*Pathways in Science 2: Physics* Unit II, Chapters 1-3 Unit IV, Chapter 1 *Concepts and Challenges in Science: Book 1; Physics* Unit I, Sections 1-5 Unit III, Sections 25-28	Matter and Change	*Pathways in Science 1: Chemistry* Unit II, Chapters 6-11 Unit III, Chapters 13-18 *Concepts and Challenges in Science: Book 1; Chemistry* Unit I, Sections 8-10 Unit II, Sections 13-19

Correlation Chart (Core Objectives)

Materials for Disadvantaged Students

Core Topics	LIFE SCIENCE	Core Topics	ENVIRONMENTAL SCIENCE	Core Topics	EARTH SCIENCE
Reproduction and Heredity	*Pathways in Science 3: Biology* Unit I Unit II, Chapters 3-4 Unit III, Chapters 9-12 Unit IV, Chapters 18-20 *Concepts and Challenges in Science: Book 3; Biology* Units I-III *Cambridge Work-A-Text: Science is Experimenting* Unit I, Chapter 3 *Cambridge Work-a-Text: Science is Predicting* Unit 1, Chapter 3 *Exploring Living Things* Unit V, Chapter 24 Unit VI, Chapter 26	Terrestrial Ecology	*Exploring Living Things* Unit II, Chapters 5-8		*Pathways in Science 2: Earth Science* Unit I, Chapters 1-2 Unit II, Chapters 3-9 and 11-12 Unit III, Chapters 13-15 *Concepts and Challenges in Science: Book 2; Earth Science* Units I and II

Correlation Chart (Core Objectives)

Materials for Disadvantaged Students

Core Topics	SPACE SCIENCE	Core Topics	PHYSICS	Core Topics	CHEMISTRY
The Universe	*Pathways in Science 3: Earth Science* Unit IV, Chapters 19-23 *Concepts and Challenges in Science: Book 3; Earth Science* Unit I, Sections 3-5 *Laboratory Program Concepts and Challenges in Science: Book 2; Earth Science* Sections 1 and 2	Force, Work and Motion	*Pathways in Science 2: Physics* Unit II, Chapters 4-8 Unit III, Chapters 1-8 *Concepts and Challenges in Science: Book 2; Physics* Unit III, Sections 14-20 Unit IV, Sections 21-23	Chemical Interactions	*Pathways in Science 1: Chemistry* Unit IV, Chapters 23-31 *Concepts and Challenges in Science: Book 1; Chemistry* Unit II, Sections 19-22 Unit III, Sections 23-24 *Laboratory Program Concepts and Challenges in Science: Book 1; Chemistry* Section 5

APPENDIX
C

HELPFUL HINTS FOR TEACHING SPACE SCIENCE

BY WILLIAM T. PETERS, THE MANITOBA PLANETARIUM, WINNIPEG

OBSERVING THE SUN

Watching the sun is a fun Astronomy project that students can try during school hours. All that is needed is a small telescope and a smooth white card. If your school or your school board science consultant can't come up with a telescope, ask your students. Small astronomical telescopes are becoming quite common.

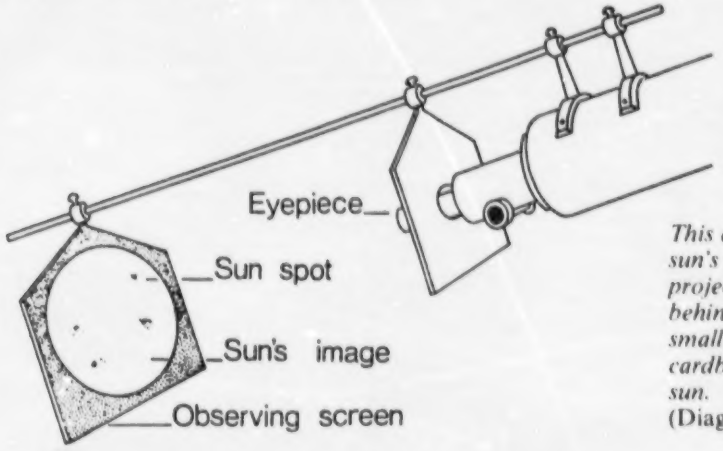
CAUTION: The eye can be blinded or injured by a direct look at the sun with a telescope. Warn your students never to look directly at the sun, with or without a telescope. The sunfilters, intended to fit over an eyepiece, which often come with small telescopes, are unsafe.

The safe, simple way to observe the sun is to use the telescope to project its image onto a white card as shown in the diagram. Many fancy gizmos are sold to hold a projection card in place on the telescope, but handholding it or taping it to a chair works fine.

Point the telescope towards the sun by watching its shadow. When it casts a perfectly round shadow it is pointed correctly. Then hold the card about a foot behind the telescope's eyepiece. A little fine tuning with the focusing knobs and some minor adjustments in pointing the telescope should turn the bright fuzzy blob on the card into a crisp image of the sun. More detail can be seen in the sun's image if it is projected into a shady spot. Try poking a hole in a piece of cardboard and placing it over the telescope tube to cast a pool of shade around the projected image of the sun.

Some new, mass produced telescopes like the Edmund Astro-Scan and the Celestrons advise in their instructions against using them for projecting the sun because the heat could damage the plastic parts inside the telescope. Celestron and several other firms who advertise in Sky and Telescope Magazine (49 Bay State Road, Cambridge, Mass., 02138) offer safe filters which fit over the front of the telescope. These filters work very well, but only one person at a time can look. You cannot measure sunspots when you use these filters.

Sunspots: These appear as irregular black specks. How big are they? Measure the diameter of your solar image and the diameter of a sunspot near the center of the image. Divide the diameter of the spot by the diameter of the solar image and multiply the result by the sun's diameter (1,392,000 km). This will give you the diameter of the spot in kilometers. Compared with the size of the earth, sunspots are surprisingly large. The sun's rotation and changes in the number and shape of sunspots are easy to observe. Have your students trace the sun's image several times over a period of a couple of weeks or more.



This diagram shows one simple set-up for projecting the sun's image. Some telescopes use a mirror or a prism to project the image off to one side, rather than directly behind the eyepiece as shown here. If your telescope has a small finder on the side, cap it or cover its front lens with cardboard and tape before pointing the telescope at the sun.
(Diagram by William Ireland, McLaughlin Planetarium)

Atmospheric Turbulence: The telescope magnifies the effect of heat waves in our atmosphere causing the sunspots and the edge of the sun's image seemingly to ripply and shimmer.

The Earth's Rotation: Ask your students why the telescope must be adjusted every few minutes to keep it pointed toward the sun.

Limb Darkening: The sun's disk appears distinctly darker towards the edge.

FURTHER READING

Parker, E.N.; "The Sun", *Scientific American*, Vol. 233, No. 3, September 1975.

Brown, Sam; *All About Telescopes*, Edmund Scientific Co. (Manitoba Museum Gift-shop), has additional hints for observing the sun.

BINOCULAR ASTRONOMY

Exploring the sky with binoculars is an excellent first hand introduction to Astronomy. Binoculars are much more available, and much easier to use than telescopes. They can provide remarkably good views of many sky objects.

To show sky objects well, binoculars must be held very steady. Ideally they should be mounted on a tripod or on a clamp with one of the adapters sold for this purpose by the larger camera stores. Bracing the binoculars against a fence post, railing or door jamb, to reduce the tremors due to our beating hearts and breathing lungs, can work almost as well.

Here are some objects to explore:

The Moon: Binoculars reveal many craters, and the details of the dark 'seas'. It is fun to watch the shadows on the Moon change from night to night. Use a small Moon-map to identify the features that you can see.

Jupiter: The four moons discovered by Galileo are easy to spot. Watch how they change position from night to night.

The Pleiades Star Cluster: The cluster is also known as the Seven Sisters. The eye alone reveals six or seven stars; seen through binoculars it becomes a splendid sight with dozens of stars visible.

The Orion Nebula: The middle 'star' of Orion's sword is really a glowing cloud of gas. Even today new stars are forming in this cloud.

There is much more to see. Encourage your students to use books like *The Sky Observers Guide* (by Mayall, Mayall and Wyckoff, The Golden Press, N.Y.) to find the Hyades, the 'Beehive' in Cancer, the Andromeda Galaxy and other interesting sights that they list. Getting out of town, away from city lights and haze, helps for observing nebulae, star clusters and the Milky Way. Good observing.

MODEL ROCKETS

There are two kinds of amateur rockets, 'Model Rockets' and the home-brew variety. Home-brew rockets, where the maker builds the rocket motor, mixes the fuel and lights the fuse are both illegal and very dangerous. 'Model Rockets' are a completely different story.

Model rocketry has recently assumed its place with model airplanes, model railroading, kiting and plastic kit building as a safe, enjoyable and educational hobby. Rocket models are made from kits. Usually the kit is a scale model of a military or research rocket.

The rocket motors used to launch the models come already loaded with fuel. The motors can only be purchased by an adult. A motor is slipped into the model just before launch. Then the model rocket is placed on a standard model rocket launcher, and fired from a safe distance by an electric signal. The launcher (about $30) is by far the most expensive item needed.

Model rocketry is regulated by the Explosives Branch of Energy, Mines and Resources Canada, Ottawa, Ontario K1A 0E4. Model rocket engines are classified as fireworks. The Explosives Branch will provide a copy of *The Manual of Model Rocketry* upon request. The *Manual* outlines the safety rules and laws governing the launching of model rockets. These handbooks are also available at the hobby shops which sell model rocket supplies. All local fireworks regulations must also be complied with.

Rocketry is a great way to provide hands-on experience during a Space Science unit. The less complex models are inexpensive and simple enough for an average grade seven to assemble, yet they can be refined and developed to a degree that maintains the interest of many high school and adult model rocket enthusiasts. And the finished models really do something!

Launch day is an exciting time for everyone, and there is much to discuss afterwards. How high did the rockets go? A protractor with a string and weight attached or the simple astrolabes used for some school Astronomy projects will tell the tale with the help of a scale diagram. Does everyone measure the same height for each launch? Why not? Why do some

rockets fly better than others? Did the lighter rockets go higher? Does streamlining make a difference?

It is advisable to make and launch a model rocket of your own before trying rocketry as a class project. This will permit a first hand evaluation of the activity both from a safety and an educational viewpoint. Hobby shops selling rocket supplies should be able to put you in touch with a model rocket club or an individual enthusiast who will provide the use of a launcher and possibly assistance later if a class launch day is planned.

If there is no one in your area using model rockets already, don't be discouraged. Someone has to be first. The instructions that come with the kits are usually very clear and easy to follow. The Manitoba Planetarium will supply the names of firms selling rocket supplies. If you use model rockets we would be interested in hearing your evaluation of the activity.*

PERIODICALS

Astronomy. Astro Media Corporation, 411 East Mason Street, Milwaukee, Wisconsin, 53202. $12.00

Blue Jay. Saskatchewan Natural History Society, P.O. Box 1321, Regina, Saskatchewan, SWP 3B8. $3.00

Manitoba Naturalist. Manitoba Naturalists' Society, 214-190 Rupert Avenue, Winnipeg, Manitoba, R3B 0N2. $2.50

National Geographic World. National Geographic Society, 17th and M Streets N.W., Washington, D.C., 20036.

Natural History, American Museum of Natural History, 79th Street and Central Park W., New York, N.Y., 10024. $10.00

Science Digest. Hearst Magazines, 224 West 75th Street, New York, N.Y., 10019.

Science World. Scholastic Magazines Inc., 50 West 44th Street, New York, N.Y., 10019.

Sky and Telescope. Sky Publishing Corporation, 49 Bay State Road, Cambridge, Massachusetts, 02138. $10.00

Weatherwise. American Meteorological Society, 45 Beacon Street, Boston, Massachusetts, 02108. $8.00

* Additional regulations and recommendations can be found in *Safety in Science for Manitoba Science Teachers*, 1973.